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INDO-PACIFIC FISHERY COMMISSION

Report of the fourth Session of

THE INDO-PACIFIC FISHERY COMMISSION WORKING PARTY OF EXPERTS ON INLAND FISHERIES

Kathmandu, Nepal, 8-14 September 1988

and

Report of the Workshop on

THE USE OF CYPRINIDS IN THE FISHERIES MANAGEMENT OF LARGER INLAND WATER BODIES OF THE INDO-PACIFIC

Kathmandu, Nepal, 8-10 September 1988

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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PREPARATION OF THE DOCUMENT

This document is the final version of the report adopted on 14 September 1988 by the participants at the Fourth Session of the Indo-Pacific Fishery Commission Working Party of Experts on Inland Fisheries, which met in Kathmandu, Nepal, 8-14 September 1988. It also includes the Report of the Workshop on the use of cyprinids in the fisheries management of larger inland water bodies of the Indo-Pacific, held in Kathmandu, Nepal, 8-10 September 1988.

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ABSTRACT

This document presents a review of the activities in inland fisheries during the intersessional period 1986–1988, and the results of discussions during the Fourth Session of the IPFC Working Party on Inland Fisheries, which met in Kathmandu, Nepal, 8–14 September 1988. It also includes the Report of a Workshop on the use of cyprinids in the fisheries management of larger inland water bodies of the Indo-Pacific, which met during the Fourth Session of the Working Party. Edited papers presented during the Workshop and country status reports are issued as a supplement to this report.

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RECOMMENDATIONS OF THE FOURTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES

1. The Working Party emphasized the need to pay full attention to the development of coldwater fisheries resources in the tropical and subtropical countries of the Indo-Pacific and recommended that FAO assist member countries with the following: establishing inventories, classification of waters with respect to their suitability for fisheries, identification of suitable fish species for cold waters, and developing appropriate technology for mass production of seed of native fish species for stocking.

2. Since in a number of countries rivers represent an important fishery resource, the Working Party suggested than an in-depth assessment of the riverine resources be undertaken with special consideration given to their significance for fisheries, and recommended that FAO, through IPFC, draw attention of the concerned governments to the need for giving priority to such investigations.

3. Large, non-regulated rivers of the humid tropics need to be better understood to determine reasons behind sudden changes in fish stocks (e.g. hilsa in Sarawak) and the Working Party recommended that FAO, with the assistance of countries with such large rivers, i.e. Burma, China, Indonesia, Malaysia and Papua New Guinea, collect and collate information and identify areas in need of improved fisheries management.

4. Recognizing the potential importance of irrigation and other canals for fisheries development in the region, especially in arid and semi-arid countries, the Working Party recommended that FAO coordinate information retrieval on this subject during the next intersessional period, and that the situation be reviewed during the next session of the Working Party, with the possibility of holding a special workshop.

5. The Working Party, recognizing that in some Indo-Pacific countries tilapia capture fisheries are of considerable importance, recommended that this matter be discussed at a session of the future Working Party, and a workshop be arranged jointly with the IPFC Working Party on Aquaculture, subject to the possibility of holding both working parties back-to-back.

6. The Working Party endorsed the current activities in developing predictive fish yield models for geographical areas and countries of the Indo-Pacific. Recognizing their potential use for fish yield enhancement, recommended that FAO set up a Task Force to identify the steps that need to be taken in evolving such models, including those that will be particularly useful in the selection of appropriate strategies and practices for the stocking of cyprinids in the region. Such models should be developed on the basis of both technical and socio-economic considerations.

7. The Working Party endorsed the recommendations of (i) the Expert Consultation on inland fisheries of the larger Indo-Pacific islands, Bangkok, Thailand, 4-9 August 1986, that a similar consultation on inland fisheries and aquaculture of the Indo-Pacific islands be held in the future to develop strategies for inland fisheries enhancement, and of (ii) the Seventh Session of the IPFC Working Party on Aquaculture, Bangkok, Thailand, 1-6 August 1988, that full support be given to aquaculture development on the Indo-Pacific islands. The Working Party on Inland Fisheries therefore recommended that an expert consultation be jointly organized with the Working Party on Aquaculture in the near future.

REPORT OF THE FOURTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES

The Working Party was convened from 8 to 14 September, 1988, in Kathmandu, Nepal. After placing garlands and flowers on the portraits of their Majesties King and Queen, the Session was opened by Mr. S.N. Regmi, Director-General of the Department of Agriculture. This was followed by the speeches of Mr. T. Petr, Technical Secretary of the Working Paty of Experts on Inland Fisheries of the Indo-Pacific Fisheries Commission; Mr. V.L.C. Pietersz, Secretary of the Indo-Pacific Fisheries Commission; Mr. S.S. Mahdi, FAO Resident Representative in Nepal; Mr. A.N. Rana, Secretary of the Ministry of Agriculture; Mr. A.T. Lama, Honorable Assistant Minister of Agriculture; Mr. K.C. Shrestha, Honorable State Minister of Agriculture; and Mr. H.B. Gurung, Deputy Director General of Agriculture.

The first three days of the meeting were devoted to the Workshop on the use of cyprinids in the fisheries management of larger inland water bodies of the Indo-Pacific. Dr. Thiraphan Bhukaswan, Senior Inland Fishery Adviser of the Department of Fisheries of the Government of Thailand was elected Chairman of the Workshop, and Mr. B.P. Sharma, Acting Chief Fisheries Development Officer, Fisheries Development Division of Nepal Department of Agriculture, was elected Chairman of the deliberations of the Working Party.

The agenda and list of participants are appended in Annexes A and B.

The list of papers contributed to the Workshop is given in Annex C and the full versions of the papers are produced in the supplement to this report.

A. WORKSHOP ON THE USE OF CYPRINIDS IN THE FISHERIES MANAGEMENT OF LARGER INLAND WATER BODIES OF THE INDO-PACIFIC

1. BACKGROUND

During the last decade, much progress has been achieved in the region in the application of hatchery technology for the mass production of carp fry for stocking in lakes and reservoirs and for culture in ponds, pens and cages. Chinese, Indian major, and common carps are now widely used in the management of inland water bodies in the Indo-Pacific. Their yields, however, have been highly variable, both between water bodies and between years, not only as a result of geographic location, climate, and variations in productivity, but also because of differences in reservoir or lake size, presence/absence of predatory fish, stocking rate and other management approaches.

Recognizing the importance of the carp fisheries in the region, the IPFC Working Party of Experts on Inland Fisheries, at its Third Session in 1986, recommended that the use of carps in inland fisheries management be made the topic of the Workshop in its next session. This request was supported by the IPFC Expert Consultation on Inland Fisheries of the Larger Indo-Pacific Islands, also held in 1986, which pointed out the lack of knowledge on the interaction of cyprinids with tilapias in the same water bodies, as well as the need for a comparative evaluation of the costs and benefits of stocking them in lakes and reservoirs in the region.

In line with these recommendations, the IPFC Secretariat organized the present workshop with the objective of reviewing the current situation on the use of cyprinids in the management of the fisheries of the larger inland water bodies in the region, and putting forward suggestions and recommendations for future action.

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The Workshop held from 8 to 10 September 1988, was conducted in three parts: (i) introduction, and presentation of three resource papers; (ii) presentation of seven country and experience papers; and (iii) general discussions, review of the workshop report, and preparation of recommendations.

The list of workshop participants is given in Annex B and the list of papers presented and their authors in Annexes C and H.

2. PAPERS PRESENTED AND SUBSEQUENT DISCUSSIONS

2.1 Resource Papers

Stocking of carps has been recognized as a tool in increasing and sustaining fish yields in large water bodies in most IPFC member countries. Fast-growing, large-sized species of Indo-Gangetic and Chinese origin are generally preferred for the following reasons: (i) they occupy all the trophic levels in reservoirs and lakes and lead to good fisheries; (ii) they supplement poor stocks and supplant inferior species; (iii) their use in culture-based reservoir fisheries as well as in pen and cage culture could be profitable.

The Indian major carps, in general, have performed well in a number of reservoirs in India and Thailand. In some Indian reservoirs like Stanley Reservoir and Sathanur Dam, where populations are sustained by natural spawning in the associated river systems, high yields have been attained with Catla catla and Labeo calbasu even with minimum stocking. In others, (e.g., Bhavanisagar, Mettur Dam, Vaigai and Ramgarh) the beneficial effects of stocking rohu have been shown in the catches. Mrigal has also performed well in Sathanur, Ramgarh, and Uppar reservoirs, where it is not known to spawn but where it is stocked regularly.

Other important indigenous carps like Labeo fimbriatus, Cirrhinus cirrhosa, and Puntius dubius did not do well even when stocked intensively and seemed to be affected by altered hydrobiological conditions and by later stocking.

In large reservoirs, tilapia does not affect the carp fishery. Large predators like Wallago attu and small predators like Notopterus notopterus reduced the dominance of tilapia without interfering with the major carp stocks. In smaller reservoirs of southern India, tilapia has been giving fairly high yields, but the stocked carps failed to appear in the catches. Experience with Chinese carps has been varied: while stocking of the Chinese silver carp seems to have been successful in southern reservoirs, the same cannot be said of common carp despite repeated stocking.

On the whole, the success of stocking programmes depends on natural breeding and/or adequate stocking. In the Philippines common carp is found in all major lakes and reservoirs and spawns naturally. In Thailand the large-scale artificial breeding and heavy stocking of rohu fingerlings is clearly reflected in the catches.

In Gobindsagar Reservoir (India), the contribution of the indigenous major and minor carps to total fish production has declined drastically from 53 percent in 1974 to 13.8 percent in 1987. In contrast, the percentage contribution of the exotic carps, mainly silver and common carp, increased significantly from 14 to 79 percent in the same period. Annual production of the reservoir ranged from 171 to 865 tons between 1974 and 1987. The major reasons cited for the decline of the fishery for the indigenous species are inadequate stocking and uncontrolled fishing for the broodstock. The complex interactions among the different indigenous and exotic carp species and between the fisheries and the physico-chemical conditions in the reseroir need to be analysed and the results used in future management of the reservoir fisheries. There is also a need for designing fishing gear for efficient capture of fish stocks of deeper water layers.

In Sri Lanka, tilapia is the dominant species in almost all reservoirs although the exotic carps have been shown to be suitable for stocking in the smaller seasonal tanks. Indigenous cyprinids like Puntius sarana and Labeo dussumieri have been contributing to the commercial catches but seem to have decreased in importance as shown by recent data from several reservoirs. There is considerable potential for the production of minor cyprinids in the larger reservoirs, with two to threefold increases in yields predicted for these cyprinids using selective fishing.

The Working Party suggested that an objective assessment of success or failure of any one group of fish, such as carps, be based on stocking efficiency (or the ratio of yield to weight stocked per unit area) and percentage return of individual fish. A final evaluation of stocking success in perennial reservoirs should use the above criteria.

2.2 Country Reviews

In China, carp stocking into lakes, reservoirs, rivers and river arms, and irrigation canals, is a widespread practice. Carp fry are either produced by induced spawning (122.7 x 10^9 fry/yr) or collected from rivers (15.6 x 10^9 fry/yr). China has 417 species of cyprinids, of which silver and bighead carp are the most common species for lake and reservoir culture. China has also used new species like Carassius auratus cuvieri, which has been introduced from Japan, for polyculture with Chinese carps in ponds. This species has a faster growth rate, larger size, stronger adaptability, easier catchability, and better tolerance to diseases than the indigenous C. auratus. Considering that China's experience with this species may prove valuable to other countries, it was suggested by the Working Party that a paper be prepared and submitted to the Secretariat for assessment and dissemination to other IPFC member countries.

In Indonesia, carps have been widely used as a tool in the fishery management of lakes and reservoirs, either to increase fish production through capture/culture fisheries, or to improve fish species composition in a reservoir. The most important carp species are tawes (Puntius gonionotus), common carp (Cyprinus carpio), and nilem (Osteochilus hasselti).

Common carp has been highly successful in areas of the country east of the Wallace line, including high-altitude lakes of Irian Jaya. However, in one such lake, common carp has had a negative impact on the endemic crayfish Cherax sp.

In Indonesia, stocking of carps or other species into lakes and reservoirs has not been conducted on a regular basis, mainly due to the insufficient supply of fingerlings. The lack of accurate data on quantities of fingerlings stocked vis-a-vis the volumes harvested, prevent a quantitative evaluation of the actual contribution of carp stocking to fish production in reservoirs. There is a need to improve statistics collection and monitoring of such management programmes.

In Nepal, where waters are either warm (subtropical and tropical) or cold (temperate), carp management has concentrated on two major strategies: (i) stocking of common carp, Chinese carps, and Indian major carps into ponds and enclosures in some lakes; and (ii) establishment of breeding and fry/fingerling production techniques for coldwater species like katle (Acrossocheilus hexagonolepis) and Schizothorax spp. and Tor spp. Warmwater carp production has been very successful, with cage culture of silver and bighead carp in lakes of the Pokhara valley now being pursued by 200 out of 300 low-income families as a means of improving their living conditions. Stocking of river systems with hatchery-produced coldwater carp species has not taken off due to a number of production constraints which still need to be overcome. Furthermore, the shortage of baseline data on river water quality and the suitability of rivers for stocking of coldwater carps, hampers the progress of the river fishery enhancement programme using indigenous species for stocking.

In spite of these constraints, Nepal is leading the field in research on the biology and production of coldwater fish. However, the country needs further assistance with respect to training, fish feed formulation for young stages of fish, survey and classification of river and streams, and the identification of the most appropriate technologies for mass production of fingerlings of coldwater cyprinids. Considering that in Nepal rivers represent the largest water surface area available (at 395 000 ha as compared to 1 500 ha of reservoirs and 5 000 ha of lakes), it was suggested that efforts be directed toward the development and/or rehabilitation of their fisheries, including the identification of species with potential for the tourism industry, for which the country is very well known.

The Philippines is perhaps the only country in the region where carps have not been extensively used in the management of the fisheries resource of inland water bodies. It is only in Lakes Lanao and Mainit that endemic cyprinids are present - and in declining numbers, mainly as a result of competition with introduced species like goby and tilapia. Thus, the contribution of the endemic cyprinids in Lake Lanao has declined from about 49 percent in 1963-64 to 28 percent in 1979, and less than 0.6 percent in 1987. In contrast, the combined contribution of gobies and tilapia has risen to a high 4 700 tons or 63.6 percent of total fish production of the said lake in 1987.

Among the exotic carps (common, bighead, silver, grass and rohu) introduced into the country's lakes and reservoirs, only common carp is found in all the major lakes in significant quantities, perhaps as a result of their ability to spawn naturally and establish populations in these waters. The others appear only occasionally in the catches from the lakes and reservoirs because they have to be artificially bred and stocked regularly if their populations are to be sustained. Recently, however, the successful adoption of the Chinese spawning technology and the demonstrated technical and economic viability of bighead carp culture in fishpens in Laguna de Bay have resulted in the wider use of this species in culture. The only constraint to the expansion of the carp culture industry in the country is the selective consumer preference and therefore limited marketability of some species. In time carp may eventually become an important food fish in the Philippines in much the same way that the perception of tilapia has changed from that of a trash fish to that of a highly acceptable commodity.

In Sri Lanka, lake and reservoir fisheries has been dominated by tilapia. Common carp yields have been insignificant, except in a few hill country reservoir. Chinese and Indian major carps have made some impact in a few reservoirs, where especially rohu has given significant yields. The two-mesh-size approach to harvesting of large and small cyprinids has been experimentally tested and has shown that no damage by either mesh size occurs to the other stock, and that considerable quantity of fish can be harvested in addition to the present yields.

In Thailand, cyprinids are an important species on account of their general abundance, their ease of capture, and their consumer acceptability regardless of size and species. Thailand has about 250 endemic species, of which several are attractive ornamentals, and about eight exotic carps, among which common carp, rohu, and Chinese carps now constitute about 10 percent of the total cyprinid catch from lakes and reservoirs. Cyprinids represent about 35 percent of inland water capture fishery and altogether bring in an annual revenue of about 300 million baht (US$ 1 = 25 baht). Although it is difficult to compare the cost of production of stocked fingerlings with the value of the fish harvested, the ratio of approximately 3 million baht to 300 million baht is a clear indication that Thailand has developed an economically sound management stategy.

3. SUMMARY AND RECOMMENDATIONS

The Workshop has highlighted the similarities and differences in cyprinid significance, not only among the various countries in the region, but also among different areas within each country. In countries or geographical areas west of the Wallace line (e.g., India, Nepal, Thailand, China and western parts of Indonesia), cyprinids occur naturally and are of high fisheries importance. In contrast, cyprinids are naturally absent in countries or geographical areas east of the Wallace line (e.g., Papua New Guinea and the eastern parts of Indonesia like Sulawesi and Irian Jaya), which therefore have cyprinid fisheries based only on introduced species. High yields have been reported for lake-associated pen and cage culture of bighead carp in the Philippines, and medium yields have been obtained in the high-altitude/mountain lakes of Irian Jaya. In Sri Lanka, the exotic carps have made some impact in some medium-sized reservoirs and have been shown to be suitable for fisheries management of seasonal tanks.

Cyprinids constitute the dominant group of fish in most of the countries represented at the Workshop and as such, make the best tools for fish yield enhancement. But the high variability in their species-wise contribution to total fish production has posed a constraint to their wider use for stocking in inland water bodies in the region. Other factors that have constrained the optimum utilization of inland water bodies for cyprinid production include the following: (i) difficulty of estimating the carrying capacity of a water body; (ii) poor knowledge on the suitability of fish species for stocking and on the potential returns from such stocking; (iii) poor data on fishing effort; and (iv) impossibility of differentiating between the stocked fingerlings and those derived from self-reproduction of mature fish stocked earlier.

It was suggested that each member country documents, through proper biological investigations, those lakes and reservoirs where natural recruitment of major carps occurs and collect information on the following: (i) geographical location and lake/reservoir morphometry and other pertinent physico-chemical characteristics; (ii) characteristics of the river(s) that enter the specific lake/reservoir where natural spawning occurs; and (iii) possible location of the spawning grounds in the river, lake or reservoir.

However, the Working Party noted that most of the countries have extensive data bases which could be analysed in depth in order to pinpoint significant correlations (for example, between physico-chemical and morphological characteristics of water bodies and their fish populations, both resident and introduced) and to develop predictive models that could be used as tools for fish yield enhancement in a particular country or group of countries in the IPFC region. Since FAO and ICLARM are already involved in developing such models for selected countries in the region, the Workshop recommended that FAO set up a Task Force to identify the steps that need to be taken in evolving such models, including those that will be particularly useful in the selection of appropriate strategies and practices for the stocking of cyprinids in the region. It was emphasized that such models be developed on the basis of both technical and socio-economic considerations (including cost-benefit analyses of alternative stocking practices/management approaches), as the utilization of cyprinid species for yield enhancement is often determined by social and economic factors like consumer acceptance, market demand, and profitability. It was further suggested that economic evaluation of stocking initially concentrate on countries with good data bases, such as India, Sri Lanka, and China, and utilize the combined services of a biologist and a socio-economist, possibly under an FAO-NACA-ICLARM collaborative programme.

The Workshop noted the increasing attention being focused by countries in the Himalayan belt, Indonesia (Irian Jaya) and China on coldwater riverine fisheries. It also highlighted the successful attempts of Nepal in the breeding and stocking of certain economically important coldwater species, fully endorsed its current activities in enhancing coldwater cyprinid populations, and encouraged the collection of further data on the character of rivers, hatchery breeding techniques, and fry/fingerling production, among others. Considering the potential usefulness of coldwater cyprinids in other countries of the region, particularly in view of the scarcity of species suitable for stocking cooler waters in the tropics, the Workshop recommended that FAO provide Nepal with technical assistance in training, research, and technology development for in-depth studies on coldwater cyprinids and their mass production for stocking.

B. REVIEW AND DISCUSSION OF THE IMPLEMENTATION OF THE PROGRAMME SINCE THE THIRD SESSION OF THE WORKING PARTY
(Bangkok, Thailand, 19-27 June 1986)

1. BIOLOGY

1.1 Breeding Technology for Mahaseer

In India, significant success has been achieved in breeding and seed rearing of Tor khudree. Success in the artificial breeding of T. putitora was obtained in 1977 but problems with breeding and rearing on a commercial scale remain. Successful breeding of T. putitora has likewise been achieved in Nepal although commercial-scale production of fry has yet to be reached.

1.2 Preparation of Synopses on Important Fish Species

No progress has been reported by India and no activities were undertaken by the Secretariat and by FAO. The Scretariat requested the members of the Working Party of continue to seek collaboration of research institutions and individual scientists, as this work continues to depend on the willingness of individuals to prepare such synopses.

1.3 Fish Genetic Resources

In the IPFC region, the following activities were reported: NACA coordinated a network of genetics research projects, and IDRC a network on genetic research which included training of aquaculture scientists. An ASEAN-EEC regional project on fish genetic resources was now based in Thailand. ADB/ICLARM had initiated a programme on genetic resources of tilapia. Thailand was establishing a National Fish Genetics Centre. In Europe, a World Symposium on Selection, Hybridization and Genetic Engineering in Aquaculture, sponsored and supported by the European Inland Fisheries Advisory Commission (EIFAC) and the International Council for the Exploration of the Sea (ICES), was held in Bordeaux from 27-30 June 1986. The Proceedings, edited by K. Tiews, were published in January 1987.

In the field of conservation of biological diversity, FAO identified three sectors of particular interest to fisheries: (i) the creation of reserves for the protection of species and stocks; (ii) measures for the control of movements of species and genetic material around the world; and (iii) establishment of genetically pure strains of fish species and aquatic organisms important for aquaculture. In the first case, interest centres mainly on the use of reserves as a management tool for the conservation of fisheries in rivers, lakes and reservoirs, and the possibility of setting aside bioreserves in areas of large lakes, reservoirs, or other water bodies, where fishing is permanently prohibited, in order to protect genetic diversity. It was noted that in Lake Victoria, in areas where fishing is banned, a large diversity of haplochromines survives in spite of large numbers of Nile perch. Close by, where fishing is allowed, the fish were rare. Supportive evidence should be collected from water bodies of the Indo-Pacific, especially in large lakes and reservoirs with intensive fisheries and where danger of over-exploitation exists. This would justify the recommendation on the establishment of protected zones exempt from any type of fishery activity to protect genetic diversity and to maintain reproductive capacity of natural stocks.

In the second case, FAO was particularly interested in the promulgation of codes of practice on risks inherent in ill-considered introductions of new species.

In the third case, FAO, although not directly involved at present, encouraged the establishment of collections of pure strains by other organizations.

1.4 Aquatic Weeds

During the intersessional period, FAO published an Occasional Paper on problems of aquatic weeds in Europe: "The decrease in aquatic vegetation in Europe and its consequences for fish populations" (De Nie, H.W., 1987, EIFAC/CECPI Occas.Pap., 19:52 p.). This paper refers to the effects of weed removal on fish. Another publication: "Fish, fisheries, aquatic macrophytes and water quality in inland waters" (Petr, T., 1987, Water Quality Bull., 12(3):103-6 and 128-9) reviews interrelationships among a number of biological and physico-chemical factors and fish. A review on aquatic weed impact on inland fisheries in tropical and subtropical Asia is expected to be completed during the next intersessional period.

Attention was drawn to the success of the Salvinia control project in Papua New Guinea using the weevil Cyrtobagous sp. Sri Lanka reported experiments in progress with this weevil. Indonesia expressed an interest in using Cyrtobagous and reported the use of fishes in the control of weeds, especially Puntius gonionotus and Oreochromis niloticus in the control of Hydrilla. The Secretariat informed the members of the Working Party that FAO would be willing to assist with the formulation of Salvinia control projects if requested by the governments. Controlling water hyacinth (Eichhornia) is still difficult. Thailand reported promising results on the control of this weed with the beetle Agasicles sp. and the use of a weevil for controlling the water lettuce Pistia.

When discussing the need for a review of successful cases of management of floating aquatic weeds by channelling their biomass into fish, China was identified as a country where much of such information may be available. The Working Party therefore suggested that China, in collaboration with the Secretariat, prepare such a review during the next intersessional period.

1.5 Use of Food Fish in Vector-borne Disease Control

FAO is collaborating with WHO and UNEP through the Panel of Experts on Environmental Management for Vector Control (PEEM) on vector-borne disease control using fish. The Seventh Meeting of this Panel, held at the FAO Headquarters from 7-11 September 1987, reviewed the "Effects of agricultural development and changes in agricultural practices on the transmission of vector-borne diseases". A paper on "Food fish as vector control and strategies for their use in aquaculture" (by T. Petr) was presented and appeared in: "Effects of agricultural development on vector-borne diseases (1987, AGL/MISC/12/87:87-92, FAO, Rome, Italy). In the Philippines, a Workshop on research and training needs in the field of integrated vector-borne disease control in riceland agro-ecosystems of developing countries was held in March 1987. This Workshop also included the use of fish for vector control.

1.6 Prediction of Fish Yields

The preparation of simple models for predicting fish yields from lakes and reservoirs in the IPFC region, based on materials from Indonesia, Philippines, Sri Lanka and Thailand, is to appear in the FAO Fisheries Department series of circulars during the next intersessional period.

1.7 Small Pelagic Fish in Inland Waters

The Secretariat, on request from Indonesia, provided an opinion on possible impacts of introducing the pelagic fish Clupeichthys aesarnensis from Thailand into Cirata reservoir in West Java, Indonesia. This pelagic species is an important fish in the Ubolratana Reservoir, Thailand. The participant from Indonesia reported that this introduction was being considered, taking fully into account the principles of the Code of Practice and that, apart from inviting international opinion, four internal agencies in Indonesia were discussing the possible outcome of such introduction if the Government decided to use this species for fish stock enhancement. This approach was viewed by the Working Party as a positive step within the context of a more regulated approach to fish introductions in the Indo-Pacific.

2. RESERVOIR AND LAKE RESEARCH MANAGEMENT

2.1 Preliminary inventory of fish species with potential for enhancing fish yield in lakes and reservoirs of tropical and subtropical countries of the Indo-Pacific was compiled for 32 species. This inventory was based on information received from seven countries of the region (see Annex E). The list will be expanded by additional information when it becomes available. Member countries were requested to continue their collaboration by providing such information in the future.

2.2 List of fish species introduced in the countries and geographical entities of the Indo-Pacific, compiled by R.L. Welcomme, is presented in Annex F. This list is extracted from the following publication: Welcomme, R.L. (comp.), 1988, International introductions of inland aquatic species, FAO Fish.Tech. Pap., 294:318 p., and updated.

3. RIVER AND FLOODPLAIN FISHERIES

3.1 Monitoring of Activities on Floodplain Stocking

The Secretariat reported on the FAO/UNDP project for the Government of Papua New Guinea, Phase I: Investigative phase on the Sepik River fish stock enhancement, which is now in its second year. This project collects and collates baseline information on the aquatic environment, and on the socio-economic status of human populations in the Sepik River basin. Included are extensive areas of floodplains. Considerations are being given to enhancing the fish stocks of floodplains, as well as those of the lower, middle and upper reaches of the river and its tributaries.

The Working Party drew attention to the need for clarification of the importance of fisheries in large, non-regulated tropical rivers in the region, such as those in Sumatra, Kalimantan, Irian Jaya, Burma, China, Malaysia and Papua New Guinea. The fish species composition, fish stocks and types of fisheries are poorly known. FAO was requested to assist with the preparation of a review on the present status of the large unregulated rivers, and in formulation of project proposals, if requested by the governments.

3.2 Hilsa (Tenualosa) Fishery Investigations

FAO is currently assisting the Government of Malaysia in the Sarawak hilsa fishery (Hilsa toli and Hilsa macrura), especially that which has declined considerably on the Batang Lupar River over the last two decades, probably as a result of overfishing, although man-made environmental changes cannot be excluded. The results of the project will be available by the end of 1988 and will serve as basis for the preparation of the final study report including a project proposal of hilsa management for external funding. In India, experiments on artificial spawning and seed rearing of H. ilisha were successfully carried out by the Central Inland Fisheries Research Institute, Barrackpore. The produced fingerlings were reared to 150 mm length in aerated ponds and stocked into River Tapti and Ukai reservoirs. However, the low number of available ripe brood stock is one of the constraints to introducing fingerling production on a large scale. The International Development Research Centre, Canada, published an annotated bibliography on Tenualosa ilisha (S.I.H. Jafri and G.D. Melvin: An annotated bibliography (1803-1987) of the Indian shad, Tenualosa ilisha (Ham.) (Clupeidae:Teleostei) 1988, IDRC, Canada, 84 p.).

3.3 Fish Migratory Structures

Two manuscripts on structures assisting migrations of fish other than salmonids were received by FAO and are being prepared for publication. One deals with the situation in the USSR (by Pavlov) and the other with Latin America (by Quiros). Similar review is needed for the Indo-Pacific countries. The Working Party suggested that the Secretariat prepare a questionnaire and mail it to Fisheries Departments of the Indo-Pacific countries with request for such information. It is hoped to have the information available for the next session of the Working Party.

4. COLDWATER FISHERIES

In response to the requests of governments, and as a follow up to the FAO World Conference on Fisheries Management and Development, Rome, 1984, Resolution No.8 - to develop special fisheries programmes for land-locked countries, an FAO mission visited the mountainous Himalayan regions of Bhutan, Nepal, and India in 1987 to assess their potential for coldwater fishery development. The Mission report put forward 10 project ideas in the field of coldwater fishery development (rivers, reservoirs, and streams), and training. The training should be in the form of a one-year post-graduate diploma course in coldwater fisheries management which would be established at an existing university in one of the Himalayan states of India. The university selected should have a good reputation and tradition in coldwater investigations but not necessarily in coldwater fisheries. If established, this would be the first course of this type for tropical and subtropical countries. The project ideas, as put forward by the Mission, are being studied by governments of the respective countries.

The Government of India has established under the Indian Council for Agriculture Research (ICAR), a National Research Centre for Coldwater Fisheries, at present in Haldwani (Uttar Pradesh), to deal with fish breeding and culture practices, as well as research on lakes and reservoirs in mountain regions. This Centre might assist in the development of the curriculum for such a diploma course. Nepal has already organized a two-month training course in coldwater fisheries, with special reference to Schizothorax breeding, for technical personnel, and has offered to organize again study courses on request from interested countries. Assistance within the region could also take place under TCDC arrangements.

During the session of the Working Party, participants from Nepal and observers from India expressed interest in the development of coldwater fisheries. The potential usefulness of coldwater species was discussed during the Workshop on use of cyprinids in the fisheries management of larger inland water bodies in the Indo-Pacific. It was noted that the incorporation of pertinent recommendations into a general approach to the development and rehabilitation of coldwater fisheries is desirable.

Note was also made of the importance of fisheries in rivers, in addition to those of lakes and reservoirs. In Nepal continuing progress has been reported in the field of developing coldwater fisheries in the Pokhara and Trisuli areas and there is now much interest in developing trout fisheries. There is also interest in enhancing trout fishery in India and Sri Lanka. It is believed that trout fishery, if developed in Nepal, would attract and encourage tourism, which is the major source of foreign income for the country.

In 1988, FAO organized a two-month training course on coldwater fisheries in Iran. This course covered biological and technological aspects of trout fry/fingerlings and table fish production, with four specialists involved: technologist, geneticist, feeds specialist and parasitologist/fish disease specialist. The course lectures will be printed and available for distribution in 1989.

5. MANGROVES

Progress has been reported on a number of activities: compendium of mangrove-associated species of economic importance has been prepared and is to be published as an FAO Fisheries Department Circular; information on seagrasses of the Philippines is now available as a technical report on the following

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projects: TCP/PHI/4511: Coastal rehabilitation through seagrass transplantation; database search on organisms of economic importance associated with seagrasses and on seagrass management will be carried out as one of the activities of the FAO/UNDP/ASEAN project "Coastal fisheries rehabilitation through seagrass restoration" (RAS/87/050); guidelines for the siting of aquaculture in mangroves will form part of the national seafarming resources atlases being prepared for the regional seafarming development and demonstration project RAS/87/024.

6. FISHERIES IN IRRIGATION CANALS

A consultant has been identified to prepare a review on the subject. The study will attempt to review and clarify a number of aspects such as: suitability of canals for fish production; fish species currently produced in canals; structures confining fish to sections of canals; factors limiting fish production in canals; fish energy demands and expenditures in canals; fish production in mono- and polyculture; herbivorous fish production in canals; and economic considerations.

The Working Party noted that this topic is of priority interest to the majority of the IPFC member countries, and of great relevance especially to the arid and semi-arid regions. It should therefore receive full attention in the form of an expert consultation, or a workshop, which could be held during the next working party meeting, under a tentative title, "The management of fisheries and fisheries-related activities in irrigation canals". The Workshop should include observers from countries outside the IPFC region on account of their considerable expertise in this area.

7. POLLUTION

Attention of the Working Party member countries was drawn to the FAO publication: "Review of the state of water pollution affecting inland fisheries in Southeast Asia" (Alabaster, 1986, published as FAO Fish. Tech.Pap., 260). This publication contains two recommendations on the immediate needs in the region: (i) A workshop on water quality criteria for Asian inland fisheries should be held among ASEAN countries to discuss the methodology of toxicity testing and the approach to developing water quality criteria for Asian species of freshwater fish, in preparation for the setting up of an FAO working group on water quality; (ii) There should be a digest made of information on lagoon treatment of domestic and industrial wastes in Southeast Asia with a view to its dissemination to those developing countries where such methods are likely to be effective and where a need for such information has already been demonstrated, as in the case of East Africa.

The Working Party members have been requested to draw the attention of their countries to pollution-fisheries interactions, with particular reference to the impact of diseases and pesticides on wild stocks. The Secretariat received a manuscript entitled: "A review of pesticide toxicity testing using tropical freshwater fish in Thailand", prepared by Palarp Sinhaseni. This manuscript, if further updated, will be considered for publication by FAO as a Fisheries Department Circular. The members of the Working Party have been requested to monitor such activities in their respective countries and report on them to the Secretariat. Information is also needed on persons involved in this field of research and closely related activities.

The Secretariat prepared a brief background paper on mining impacts (see Annex E), which highlighted the need to review the impacts of mining activities in the IPFC region on fish stocks, fisheries and fisherfolk. Although this was not regarded as a common problem in the region, it is considered as a relevant topic requiring the attention of some countries.

8. THE CODES OF PRACTICE

FAO works through regional fishery bodies to maintain a data base on movements of species betweeen countries and to develop international codes of practice and protocols to ensure that such transfers are scrutinized scientifically prior to being carried out. This field is of interest to a number of international agencies and a number of codes are being promulgated through a variety of ministries in member countries. As some of these are conflicting in their content and intent, confusion arises in some countries as to procedures to be followed. The Working Group on Introduction and Transfer of Marine Organisms of the International Council for the Exploration of the Sea (ICES) and the Working Party on Introductions of the European Inland Fisheries Advisory Commission (EIFAC) have prepared the codes of practice and manual of procedures for consideration of introductions and transfers of marine and freshwater organisms, which will be published soon. Dr. R.M. McDowall of the Freshwater Fisheries Centre of the New Zealand Ministry of Agriculture and Fisheries, has provided expert opinion on the suitability of the Code of Practice adopted for Europe, for the IPFC region. He concluded that the EIFAC Code of Practice forms a useful basis for discussion by IPFC, and with due recognition given to the geographical, socio-cultural, and economic differences between EIFAC and IPFC countries, can be adopted for use by IPFC.

The members of the Working Party have been requested to discuss with their respective governmental fisheries organizations the Code of Practice with regard to the specific situations of individual countries. The Working Party recognized that the differences among IPFC countries are greater than those among European countries, and that it may require more time before the Code of Practice is scrutinized and adopted in the region. The Secretariat informed the Working Party members that the Code of Practice is being considered for adoption by the FAO regional bodies for Africa and Latin America.

Dr. Sena de Silva, Chairman of the Asian Fisheries Society Standing Committee on the Study of Introductions of Exotic Species, briefly reported on the Workshop on Exotic Aquatic Introductions in Asia, held in Darwin, Australia from 21-23 June 1988. This Workshop took into account the interests and experience of the FAO/EIFAC and the American Fisheries Society on this topic and the need for the Society to liaise with these organizations.

The participant from Indonesia reported that the Code of Practice will be translated into the Indonesian language and its contents circulated among relevant internal bodies. Note was also made of the activities in Papua New Guinea in this respect (project PNG/85/001) and the experiences there on the practicability of the implementation of the Code in a developing country situation.

9. PLANNING FOR FISHERIES AND AQUACULTURE

A manuscript on "Guidelines for planning for inland fisheries under constraints from other users" is now in the editing stage and this study should appear in 1989 in one of the FAO Fisheries Department publications series.

The Legal Office of FAO has agreed to collate the existing rules and regulations on inland fisheries in the IPFC countries on a country basis. These will then be published during the next intersessional period.

FAO has also initiated the introduction of environmental impact assessment (EIA) to fishery and fishery-related projects in the region. FAO has used the approach in a number of projects, including the "Aquaculture Development Master Plan for Marine Prawn Culture in Sabah" (MAL/88/008). The EIA approach was also used in the "Study on the environmental impacts of forest utilization in Fiji" (TCP/FIJ/6652) to assess the possible impacts of long-term, large-scale timber extraction and replanting on aquatic resources. Note was also made of the potential for biomanipulation of water quality using fish and fisheries as a positive aspect of EIA, a subject that needs more attention in the future.

The UN Centre for Regional Development (UNCRD), the International Lake Environment Committee (ILEC), and UNEP held a Joint Expert Group Workshop, "A river/lake basin approach to environmentally sound management of water resources", 8-9 February 1988 in Japan. This workshop was aimed at considering efficient methods of managing water resources and training competent personnel for this purpose, especially in developing countries. Fisheries considerations were covered for the Saguling Reservoir in Indonesia, the Dianchi Lake in China, Laguna de Bay in the Philippines, and Songkhla Lake in Thailand.

10. OTHER ITEMS

(i) Updating of FAO Fisheries Circular No. 794 (Inland Fisheries of Indo-Pacific Countries): During the intersessional period, Fiji and Japan supplied their data which are now available on request from the IPFC member countries. An updated and expanded version, including additional country profiles, is preliminarily scheduled for 1992.

(ii) List of inland fisheries and aquaculture specialists (FAO Fisheries Circular No. 796, 1986) included 562 personnel and covered the following countries in the Asia and Pacific region: Australia, Burma, Indonesia, Malaysia, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam. The revision of the list is planned for the 1990-91 biennium and the Secretariat requests close collaboration of the IPFC member countries in providing additional entries. SEAFDEC compiled a Directory of Fishery Scientists and Technologists in Southeast Asia (published March 1986) which complements the above FAO circular. It covers both marine and freshwater personnel and includes 607 names from Burma, Hongkong, Indonesia, Malaysia, Philippines, Singapore, Thailand and adjacent areas. It also contains indices of names, countries and specialities.

(iii) The attention of member countries was drawn to the establishment and activities of the Asian Fisheries Society and information on its activities and purposes was circulated. A branch of the Society has been set up in India and one is planned in China in the near future.

(iv) Attention was likewise drawn to the existence of a Network of Tropical Fisheries Scientists organized under ICLARM.

(v) The Working Party drew attention to the poor knowledge in the region on the fish stocks and fisheries potential of saline (athalassic) inland waters, common in China, Australia, India, Pakistan, and Iran. This topic should be included in the agenda of the next session of the working party. This should also be brought to the attention of the Working Party on Aquaculture. The participant from Thailand commented that this was becoming a relevant subject area in the northeastern part of the country. The Working Party suggested that China prepare a background paper on their experience with fisheries in inland salt (athalassic) waters.

(vi) The Working Party acknowledged the need for increased attention to women's role in fisheries development and to children's participation in various fishing activities, and suggested that these be taken into account in the formulation of fisheries projects in the region.

(vii) The Working Party considered the benefits of holding its session back-to-back with the Working Party on Aquaculture, with a joint workshop. It recommended that the Working Party on aquaculture consider this arrangement for the next sessions of both working parties to be held in about two years' time.

(viii) The Working Party proposed the following alternatives as a topic for the workshop to be held in connexion with the Fifth Session of the Working Party on Inland Fisheries: Coldwater fisheries in tropical and subtropical countries; Tilapia capture fisheries in mainland Asia and Indo-Pacific islands; Fish and fisheries in irrigation canals; inland capture fisheries and aquaculture on the Pacific islands. Each of these topics could also be considered by an ad hoc Expert Consultation.

C. IMPLEMENTATION OF RECOMMENDATIONS OF THE IPFC EXPERT CONSULTATION ON INLAND FISHERIES OF THE LARGER INDO-PACIFIC ISLANDS

(Bangkok, Thailand, 4-9 August 1986)

The Expert Consultation had given full support to the activities of the Working Party of Experts on Inland Fisheries and requested it to assist in the implementation of its recommendations. Selected recommendations were endorsed by the Twenty-Second Session of the IPFC which met in Darwin, Australia, 16-26 February 1987, after the Expert Consultation and the Third Session of the Working Party on Inland Fisheries meetings.

Recommendations of the Expert Consultation were discussed at the present session of the Working Party and the extent of their implementation is briefly summarized as follows:

Recommendation No.1: Each country clearly identifies the indigenous species with potential for fisheries development and initiates studies on their biology, as well as limnological studies wherever necessary.

This recommendation, which was endorsed by the 22nd Session of the IPFC in Darwin supports the activities of the Working Party but broadens its scope to cover also those non-member islands. This is an ongoing activity, the depth of coverage of which will depend on information provided by individual countries.

Recommendation No.2: FAO supports a study to assess the status of the tilapia capture fisheries on the Indo-Pacific islands and mainland Asia.

No subsequent action has been reported. The present session of the Working Party strengthened this recommendation and gave it priority, especially in the context of the results of the Workshop on cyprinids. The Working Party requested that FAO consider preparation of a review on the situation during the next intersessional period, and that a Workshop on tilapia capture fisheries be held during one of the future sessions of the Working Party.

Recommendation No.3: A specialized meeting on the importance of estuaries for inland fisheries of the Indo-Pacific islands and mainland Asia be held in the near future.

Although recognized as being of interest for some countries, the present session of the Working Party has not given it high priority.

Recommendation No.4: FAO, in close collaboration with the individual countries of the region, including mainland Asia, review the current use of irrigation and other canals for fishery, and identify ways and techniques for enhancing the use of such canals for this purpose.

A review has been contracted and should be available for the next session of the Working Party. The Working Party proposed holding a Workshop on the use of irrigation canals for fish production in connexion with one of the future Working Party sessions.

Recommendation No.5: FAO organize a special meeting on the significance of the common and Asian major carps for inland capture fisheries of the Indo-Pacific islands. Such a meeting should also consider interactions of carps and tilapias where representatives of both groups are stocked in the same water body.

This matter has been addressed, in part, by the recently-concluded Workshop on the use of cyprinids in the fisheries management of the larger Indo-Pacific water bodies. The proceedings of the Workshop will appear as a supplement to this report.

Recommendation No.6: Collection and publication of inland water and aquaculture statistics from the region be given full and immediate attention by the Information, Data and Statistics Service of the FAO Fisheries Department, with the following objectives:

(i) Clear-cut definitions of "inland fisheries", "aquaculture", and "brackish waters" are needed to enable the separation of catches, landings and other statistical data.

The definition of aquaculture, adopted by the Aquaculture Steering Committee of the Fisheries Department of FAO in December 1987, is as follows:

> Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of fisheries.
>
> Explanatory Notes:
>
> The ownership of the structure in which or around which organisms are caught (e.g. fish aggregating devices or brush parks) does not confer ownership of the organisms themselves - thus their production is 'fisheries'. The juvenile output of hatcheries is aquaculture but the production of market-sized organisms resulting from the growth of those juveniles contributes to fisheries production if (as in salmon or lobster 'ranching' or inland fisheries enhancement) they are available to the public to harvest. If the juveniles produced by hatcheries remain privately owned (by an individual or a corporate body) until harvested, the result is aquaculture production.

(ii) Sources of statistical data should be duly noted for each country.

FAO has recently introduced a system of collection of statistical data for freshwater fisheries of Europe through EIFAC. This has improved details on inland fisheries. If the countries think that this could be applied in the IPFC region, such a system could be adopted. This depends, however, on the level of sophistication of data collection in individual countries. Some countries have no data collection systems for freshwater fisheries and these would therefore need to be established as a first step. The Working Party has requested that FAO/FIDI (Fishery Information, Data and Statistics Service) to provide sample forms to each member country for their consideration and adaptation for use.

(iii) The service (FIDI) should agree with other data-gathering and publishing organizations in the area on unification of the data prior to its publication.

FAO has had detailed negotiations with SEAFDEC concerning a unified statistical collection system and there is a proposal to hold a workshop in Bangkok in May 1989 on further cooperation between the two agencies in the field of the fishery statistics. FAO/FIDI fully collaborates with NACA on aquaculture data. In February 1988, discussions were also held with the South Pacific Commission in Noumea concerning possible data sharing and other forms of cooperation in the collection of fishery statistics.

(iv) Where applicable, the fact that subsistence fisheries is poorly recorded should be clearly stated in statistical yearbooks.

FAO is trying to improve the data quality, harmonize definitions, and unify collection systems in the Indo-Pacific. Member countries should give more attention to the collection of data on their respective subsistence fisheries.

Recommendation No.7: A similar consultation, including both the inland fisheries and aquaculture of the Indo-Pacific islands, be held in the future to assess progress in the individual fields of interest and to develop strategies for inland fisheries enhancement.

This recommendation also received support from the Seventh Session of the IPFC Working Party on Aquaculture, Bangkok, Thailand, 1-6 August 1988, which in its Recommendation No.6 highlighted the need for providing full support to aquaculture development on the Pacific islands. The Working Party on Inland Fisheries endorsed both recommendations and recommended that an expert consultation be jointly organized by both working parties and held in the near future.

D. SUMMARY AND RECOMMENDATIONS OF THE FOURTH SESSION OF THE IPFC WORKING PARTY OF EXPERTS ON INLAND FISHERIES

Recommendation 1

Coldwater fisheries resources in the tropical and subtropical countries of the Indo-Pacific are either underutilized (as in the highest mountain lakes and streams), or overexploited (as some lakes in China and some rivers in Nepal), or modified by pollution (as some lakes and reservoirs in India). Some coldwater lakes in China are saline. Some streams are already intensively managed, like in Kashmir for the exotic trout; some streams may still have to be studied for their suitability for fisheries development, as in Nepal where sport fishery development may need to be enhanced by introduction of trout.

The Working Party, recognizing the diversity of the coldwater bodies in the region, emphasized the need to pay full attention to the potential for fishery development of such waters. The Working Party also stressed that the following need to be undertaken in line with coldwater fisheries development in those countries with considerable potential: (i) conduct of inventories of river character and fish stocks for high- and medium-altitude lakes and rivers (as in Nepal, Bhutan, India and China); (ii) classification of waters with respect to their suitability for fisheries and their expected yields for particular coldwater fish species; (iii) identification of suitable fish species for cold waters; (iv) development of appropriate technology for the mass production of seed of native fish species for stocking of Himalaya rivers, streams and lakes in countries such as Nepal, Bhutan and India. The Working Party recommended that FAO, through TCDC or other schemes, assist the IPFC member countries and China with such activities as identified by them.

Recommendation 2

Considering that some countries in the Indo-Pacific have extensive river resources (e.g. Bhutan, Burma, India, Indonesia, Nepal, Papua New Guinea, Thailand), many of which are still unregulated by major engineering structures, and which represent an important fishery resource, especially for subsistence fisheries in lower order rivers, the Working Party suggested that an in-depth assessment of the riverine resources be undertaken with special consideration given to their significance for fisheries. The Working Party recognized the inadequacy of information and poor understanding of a number of factors related to the physical, chemical and biological environments of large, non-regulated rivers of the humid tropics. The particular importance of rivers where flow is still unimpeded by engineering structures as possible venues for studies on migratory stocks of indigenous fish was stressed. It was mentioned that the study of fish stocks in such large rivers is needed to better understand the reasons behind the sudden disappearance or drastic decline of fish, such as has been observed with hilsa in some Sarawak rivers, now the subject of investigation by an FAO project.

The Working Party further noted the shortage of qualified manpower in some of the countries, which may have contributed to the neglect of this resource in the overall fisheries development programmes in some countries.

The Working Party recommended that: (i) FAO draw attention of the concerned governments, through the IPFC, to the need to give priority to investigating the extent and value of their riverine resources and their possible enhancement for fisheries; (ii) FAO, with the assistance of the member countries, collect and collate available information on the last major non-regulated rivers in the IPFC region; (iii) member countries consider the importance of such rivers for subsistence and other types of fisheries, and, in collaboration with FAO, identify areas in need of improved management. FAO, if requested, will assist in the formulation of project proposals and their execution.

Recommendation 3

Recognizing the potential importance of irrigation and other canals in the region for fisheries development, especially in arid and semi-arid countries, the Working Party recommended that FAO coordinate information retrieval on this subject during the next intersessional period, with the possibility of reviewing the situation at a special workshop which could be held during one of the next sessions of the Working Party. The member countries are requested to provide the Secretariat with any relevant information to assist in the preparation of the preliminary assessment and synthesis of this topic before the next Working Party session.

Recommendation 4

The Working Party reiterated the recommendation of the IPFC Expert Consultation on Inland Fisheries of the Large Indo-Pacific Islands held in Bangkok, Thailand in 1986, that attention be given to capture fisheries for tilapia. The Working Party recommended that this matter be made the discussion subject of its next workshop. The possibility of holding a joint workshop with the next session of the IPFC Working Party on Aquaculture should be considered.

ANNEX A

AGENDA

8 September 1988	9:00-10:30	Opening of the Fourth Session of the Working Party
	11:00	Adoption of the Agenda Election of Chairmen and Rapporteurs
	12:30	Lunch
	14:00	Workshop on the use of cyprinids in the fisheries management of larger inland water bodies of the Indo-Pacific: Introduction (T. Petr) Resource paper 1: Fish stock enhancement in larger Indo-Pacific inland water bodies using carps and tilapias. Initial evaluation (A. Sreenivasan)
	15:30	Coffee break
	16:00	Resource paper 2: The trends of the Sri Lankan reservoir fishery with special reference to the role of cyprinids (S. De Silva)
9 September 1988	9:00	Workshop on cyprinids (continued) Resource paper 3: Gobindsagar reservoir: a case study on the use of carp stocking for fisheries enhancement (K. Kumar)
	10:30	Coffee break
	11:00	Country papers on the use of cyprinids in inland fisheries China Indonesia
	12:30	Lunch
	14:00	Country papers (continued) Nepal Philippines
	15:30	Coffee break
	16:00	Country papers (continued) Sri Lanka Thailand
10 September 1988	9:00	Workshop on carps (continued) General discussion, formulation of conclusions and recommendations

	10:30	Coffee break
	11:00	Report drafting
	12:30	Lunch
	14:00	Report drafting and typing
	16:00	Discussion of the Workshop draft report
11 September 1988		EXCURSION
12 September 1988	9:00	Review and discussion of intersessional activities (Secretary of the Working Party and participants)
	10:30	Coffee break
	11:00	Review and discussion of intersessional activities (continued)
	12:30	Lunch
	14:00	Review and discussion of intersessional activities (continued)
	15:30	Coffee break
	16:00	Discussion
13 September 1988	9:00	Identification and discussion of areas of interest for future activities
	10:30	Coffee break
	11:00	Discussion of areas of interest for future activities
	12:00	Other matters
	12:30	Lunch
	14:00	Approval of the Workshop Report
	15:30	Coffee break
	16:00	Drafting of the Session Report
14 September 1988	11:00	Discussion of the Session Report
	12:30	Lunch
	14:00	Discussion and adoption of the report of the Working Party

ANNEX B

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ANNEX C

LIST OF PAPERS CONTRIBUTED TO THE WORKSHOP ON THE USE OF CYPRINIDS IN THE FISHERIES MANAGEMENT OF LARGER INLAND WATER BODIES OF THE INDO-PACIFIC[1]

(edited by T. Petr)

1. The use of common and Asian carps in the fisheries management of larger inland water bodies of the Indo-Pacific (T. Petr)
2. Fish stock enhancement in larger Indo-Pacific inland water bodies using carps and tilapias (A. Sreenivasan)
3. The trends of the Sri Lankan reservoir fishery with special reference to the role of cyprinids (S.S. De Silva)
4. Gobindsagar reservoir: a case study on the use of carp stocking for fisheries enhancement (K. Kumar)
5. The use of carps in the fishery management of reservoirs and lakes in Indonesia (Atmadja Hardjamulia and N. Sweta Rabegnatar)
6. Status of Schizothorax species in the Indian-Chinese sub-continent (B.P. Sharma)
7. Katle (Acrossocheilus hexagonolepis), a cold-water cyprinid of Nepalese waters (A.K. Rai and D.B. Swar)
8. A review of the utilization of carps in inland fisheries management in the Philippines (Elvira A. Baluyut)
9. The use of common carp and Asian carps in the fisheries management of larger inland water bodies in Sri Lanka (A.M. Jayasekara)
10. The use of common and Asian carps in fisheries management of the larger inland water bodies in Thailand (Thiraphan Bhukaswan)

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[1] Full versions are produced as supplement volume to this Report.

ANNEX D

LIST OF FAO DOCUMENTS RELEVANT TO INLAND FISHERIES IN THE IPFC REGION, PUBLISHED DURING THE INTERSESSIONAL PERIOD (1986-88)

1. Alabaster, J.S., 1986. Review of the state of water pollution affecting inland fisheries in Southeast Asia. FAO Fish.Tech.Pap., (260): 25 p.

2. Indo-Pacific Fishery Commission, 1986. Report of the third session of the Indo-Pacific Fishery Commission Working Party of Experts on inland fisheries. Bangkok, Thailand, 19-27 June 1986, and Report of the Workshop on strategies for the management of fisheries and aquaculture in mangrove ecosystems. Bangkok, Thailand, 23-25 June 1986. FAO Fish.Rep., (370):42 p.

3. ___________, 1986a. Report of the Indo-Pacific Fishery Commission Expert Consultation on inland fisheries of the larger Indo-Pacific islands. Bangkok, Thailand, 4-9 August 1986. FAO Fish.Rep., (371):22 p.

4. Lu, X. (comp.), 1986. a review on reservoir fisheries in China. FAO Fish.Circ., (803):37 p.

5. Mepham, R.H. and T. Petr (eds), 1987. Papers contributed to the Workshop on strategies for the management of fisheries and aquaculture in mangrove ecosystems, Bangkok, Thailand, 23-25 June 1986, and Country status reports on inland fisheries presented at the Third session of the Indo-Pacific Fishery Commission Working Party of Experts on inland fisheries, Bangkok, Thailand, 19-27 June 1986. FAO Fish.Rep., (370) Suppl.:248 p.

6. Nie, H.W. de, 1987. The decrease in aquatic vegetation in Europe and its consequences for fish populations. EIFAC Occas.Pap., (19):50 p.

7. Petr, T., 1987. Food fish as vector control and strategies for their use in agriculture. In Effects of agricultural development on vector-borne diseases. Rome, FAO, AGS/MISC/12/87:87-92

8. Petr, T. (ed.), 1987a. Reports and papers presented at the Indo-Pacific Fishery Commission Expert Consultation on inland fisheries of the larger Indo-Pacific islands. Bangkok, Thailand, 4-9 August 1986. FAO Fish.Rep., (371)Suppl.:258 p.

9. Welcomme, R.L. (comp.), 1988. International introductions of inland aquatic species. FAO Fish.Tech.Pap., (294):318 p.

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ANNEX E

INVENTORY OF FISH SPECIES WITH POTENTIAL FOR ENHANCING FISH PRODUCTION IN LAKES AND RESERVOIRS OF TROPICAL AND SUBTROPICAL COUNTRIES OF THE INDO-PACIFIC

T. Petr

INTRODUCTION

The Second Session of the IPFC Working Party of Experts on Inland Fisheries, New Delhi, India, 23-27 January 1984, recommended that an inventory of fish species most suitable for enhancing fish production in lakes and reservoirs be prepared for the countries of the Indo-Pacific.

It is known that specific areas of the IPFC region contain fish species which could enhance fish production elsewhere. The knowledge of biology, ecology and fishery-related qualities of such species may be, however, limited to areas of their present distribution. Poor dissemination of relevant information on some of them has so far prevented their wider use in the region. Especially the fresh waters east of the Wallace line, which are extremely poor in fish stocks of fishery significance, could benefit from better information on the suitability of various fish species for their waters.

The present inventory is based on responses to a questionnaire distributed to the members of the IPFC Working Party on Inland Fisheries. Needless to say, it is only preliminary as it is based on a limited number of responses. However, it should encourage specialists in the field to provide further information on the subject. For their use a blank questionnaire is reproduced at the end of this paper.

The need for the inventory was expressed especially by countries where fish introductions, transfers and/or regular stocking of reservoirs and lakes has not yet been carried out, or has not been successful, i.e. the stocked species for some reason have not established themselves, or have not led to an increase in fish yield. In some situations, there has been a demand for enhancing the yield by selecting an indigenous species instead of an exotic. Such situations will be on the rise, especially in countries which are considering the adoption of the Code of Practice to reduce the risk of adverse effects arising from the introduction or transfer of inland aquatic organisms (see Annex H, in: 1986, Report of the Third Session of the IPFC Working Party of Experts on inland fisheries, Bangkok, Thailand, 19-27 June 1986, FAO Fish.Rep., (370)). This Code, now adopted by the countries of the European Inland Fisheries and Aquaculture Commission (EIFAC), stresses the need for excellent knowledge of fish species prior to their introduction to new countries or within countries from catchment to catchment. Accumulation of sound knowledge of a relatively unknown fish is a slow process, but without such knowledge it is difficult to judge the impact of a new introduction on fish stocks and on the whole aquatic ecosystem. A cautious approach is therefore needed and an investigatory research phase should precede new introductions. FAO/UNDP, in a project for the Government of Papua New Guinea, is currently investigating the possibility of introducing additional fish species into the Sepik River system, which, due to its zoogeographical isolation and the evolutionarily young age of its freshwaer fish fauna, has depauperated fish stocks giving low yields. In this situation, the decision

Table 1

LIST OF SPECIES COVERED IN THE PRESENT SURVEY
(+ reported by country)

Country Species	Australia	India	Indonesia	Nepal	Philippines	Sri Lanka	Thailand
Aristichthys nobilis				+			
Barbus sarana						+	
Bidyanus bidyanus	+						
Catla catla		+					
Chanos chanos					+		
Cirrhinus jullieni							+
Cirrhinus mrigala		+					
Corica isannensis							+
Ctenopharyngodon idella				+			
Cyprinus carpio			+	+	+		
Etroplus suratensis						+	
Hephaestus fuliginosus	+						
Hypophthalmichthys molitrix				+			
Kryptopterus apogon							+
Labeo calbasu		+					
Labeo dussumieri						+	
Labeo rohita		+					+
Lates calcarifer	+						
Macquaria ambigua	+						
Oreochromis niloticus			+		+		+
Oreochromis mossambicus					+		
Osphronemus goramy			+				
Osteochilus hasselti			+				
Oxyeleotris lineolatus	+						
Puntius gonionotus			+				+
Scleropages leichardti	+						
Scleropages jardini	+						
Strongylura kreffti	+						
Tandanus tandanus	+						
Trichogaster pectoralis			+				
Toxotes chatareus	+						
Tor tor		+					

on introducing fish new to the catchment will be based on the results of exploratory surveys and research work, and such a decision will consider all possible consequences of proposed introductions. The selected fish species will be scrutinized for their biology and ecology, interactions with other species and with the aquatic habitat as a whole, as well as for their potential socio-economic impact.

RESULTS

Information, as collected through questionnaires, is presented here under individual countries. Seven countries provided information on a total of 32 species of fish (Table 1). The questionnaire was divided into several major sections, i.e. biology/ecology (types of habitat, types of breeding, fry/fingerlings habitat requirements, adult feeding habits, diurnal and other migrations, diseases and parasites, competition); distribution (brief characteristics of individual reservoirs and lakes and their water quality); fisheries (including yields, origin of the species, stocking, aquaculture practices, competition, optimal conditions for fish, interference with achieving maximum yield, basic literature references). This information is briefly discussed below.

Australia (tropical and sub-tropical)

Table 2

LIST OF SPECIES

Species	Family
Bidyanus bidyanus	Teraponidae
Hephaestus fuliginosus	Teraponidae
Lates calcarifer	Centropomidae
Macquaria ambigua	Percichthyidae
Oxyeleotris lineolatus	Eleotridae
Scleropages leichardti	Osteoglossidae
Scleropages jardini	Osteoglossidae
Strongylura kreffti	Belonidae
Tandanus tandanus	Plotosidae
Toxotes chatareus	Toxotidae

In Australia, transplantation of species into reservoirs has been carried out on a limited scale. All species but four (S. leichardti, S. jardini, S. kreffti and T. chatareus) have been successfully artificially bred. All are found in reservoirs. T. tandanus is the most common species, listed for 15 reservoirs. On the other end of the scale is L. calcarifer which is found only in Tinnarroo reservoir.

All species prefer animal food, with the highest number of species feeding on prawns, fish, terrestrial insects or a mix of these (Table 3). Only two feed to some extent on macrophytes, aufwuchs and fruit and seeds, and only one utilizes bottom detritus. Although no information is available on their yield in reservoirs, their production is probably rather low when compared with species widely used in other countries of the region.

Table 3

ADULT FEEDING HABITS

Food Species	bottom detrit.	benthic fauna	auf- wuchs	macro- phytes	fuits seeds	zoo- pl.	terr. insects	crabs	prawns	fish
Bidyanus bidyanus	+	+	+	+	-	+	+	-	+	-
Hephaestus fuliginosus	-	+	-	+	+	-	+	-	+	+
Labeo calbasu	-	-	-	-	-	-	+	+	+	+
Macquaria ambigua	-	+	-	-	-	-	+	+	+	+
Oxyeleotris lineolatus	-	+	-	-	-	-	-	+	+	+
Scleropages leichardti+ S. jardini	-	-	-	-	-	-	+	+	+	+
Strongylura kreffti	-	-	-	-	-	-	-	-	-	-
Tandanus tandanus	-	+	-	-	-	-	+	-	+	-
Toxotes chatareus	-	-	-	-	-	-	+	-	+	-

India

Table 4

LIST OF SPECIES

Species	Family
Catla catla	Cyprinidae
Cirrhinus mrigala	Cyprinidae
Labeo calbasu	Cyprinidae
Labeo rohita	Cyprinidae
Tor tor	Cyprinidae

Five cyprinid species are the preferred fish for fish yield enhancement in the sample of 12 reservoirs. All fish but *Tor tor* are common to a wide range of reservoirs, with water conductivities up to 1 112 micromhos. The percentage by weight in total landings varies widely, with catla reaching 99 percent of the total (Rihand reservoir), mrigal 71 percent (Rana Pratap Sagar), calbasu 47 percent (Bhavanisagar), rohu 52 percent (Ukai) of the total. *Tor tor* is regularly stocked in three reservoirs where it forms up to 21 percent (Rana Pratap Sagar) of the total. The other four carp species are regularly stocked into the listed Indian reservoirs. Fish yield data in kg/ha/year are not given. All fish breed naturally in some catchments (Ganga River and its tributaries), but are also bred artificially where natural propagation does not take place.

Adults show feeding preference for small particulate matter, usually of plant character, although three species feed on macrophytes as well. In *Tor tor* macrophytes represent 66 percent of the total food by weight. Fish is a rare item in this species. All five species undergo up-river migrations.

Table 5

ADULT FEEDING HABITS

Food Species	bottom detrit.	bottom mud	macro-phytes	fruits seeds	phyto-pl.	filam. algae	zoo.-pl.	mol-luscs	terr. ins.	fish
Catla catla	+	+	+	−	+	−	+	−	+	−
Cirrhinus mrigala	+	+	−	−	+	−	+	−	−	−
Labeo calbasu	+	+	−	−	+	−	+	−	−	−
Labeo rohita	−	+	+	−	+	−	+	−	+	−
Tor tor	+	+	+	+	−	+	−	+	−	+

Indonesia

Table 6

LIST OF SPECIES

Species	Family
Cyprinus carpio	Cyprinidae
Oreochromis niloticus	Cichlidae
Osphronemus goramy	Anabantidae
Osteochilus hasselti	Cyprinidae
Puntius gonionotus	Cyprinidae
Trichogaster pectoralis	Anabantidae

All species breed naturally. *O. niloticus* and *P. gonionotus* are also bred artificially. *O. goramy*, *P. gonionotus* and *T. pectoralis* are indigenous to the reservoirs; the other three species (exotic) are regularly stocked. *O. goramy* and *P. gonionotus* regularly migrate into the inflowing rivers and streams. The highest yields recorded are *O. niloticus* which reached 227 kg/ha and 110 kg/ha in Lake Ciburuy and Lido Lake respectively. Among the endemics, *P. gonionotus* reached 597 kg/ha in Curug reservoir. *O. hasselti* gave 65 kg/ha in Lake Rawa Pening. The yield of *T. pectoralis* was very low. *C. carpio* was produced in cages in Curug.

Primary producers (algae, macrophytes), detritus, decomposing plants, and plankton are the major source of food of these fish. This supply of food is usually present in abundance, supporting a high biomass of these predominantly herbivorous fish.

The maximum yields for *O. niloticus*, *P. gonionotus* and *O. hasselti* are high and provide an indication of the level of yields which might be achieved in regularly stocked reservoirs.

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Table 7

ADULT FEEDING HABITS

Species \ Food	bottom detritus	bottom mud	benthic fauna	auf-wuchs	mcro-phytes	phyto-pl.	zoo-pl.	terr. insects
Cyprinus carpio	+	–	+	–	+	–	+	–
Oreochromis niloticus	+	–	+	+	+	+	+	+
Osphronemus goramy	+	–	–	+	+	–	–	–
Osteochilus hasselti	+	–	–	–	–	+	+	–
Puntius gonionotus	+	–	–	+	+	+	+	–
Trichogaster pectoralis	+	–	–	+	–	+	+	–

Nepal

Table 8

LIST OF SPECIES

Species	Family
Aristichthys nobilis	Cyprinidae
Ctenopharyngodon idella	Cyprinidae
Cyprinus carpio	Cyprinidae
Hypophthalmichthys molitrix	Cyprinidae

C. carpio and *A. nobilis* are reported to breed in Nepal naturally, and all four species are also bred artificially. All four species are now present in three natural lakes of the Pokhara valley, i.e. Phewa, Begnas and Rupa. The maximum yields (total landings) are given as 220 kg/ha/year (Rupa), 84 kg/ha/year (Begnas), and 40 kg/ha/year (Phewa). Yields for individual species are not available, but *H. molitrix* in Lake Rupa represents 75 percent, followed by *A. nobilis* (20 percent), *C. carpio* (2 percent), *C. idella* (2 percent) in the total.

The feeding spectrum of adult fish is given in Table 9.

At the present population densities, no food competition in adult stages has been reported. The major problem of achieving higher yields in Pokhara lakes is seen in the shortage of the stocking material.

Table 9

ADULT FEEDING HABITS

Species \ Food	bottom mud	benthic fauna	macro-phytes	phyto-plankton	zooplankton
Aristichthys nobilis	–	–	–	+	+
Ctenopharyngodon idella	–	–	+	–	–
Cyprinus carpio	+	+	–	+	+
Hypophthalmichthys molitrix	–	–	–	+	+

Philippines

Table 10

LIST OF SPECIES

Species	Family
Chanos chanos	Chanidae
Cyprinus carpio	Cyprinidae
Oreochromis niloticus	Cichlidae
Oreochromis mossambicus	Cichlidae

The milkfish (C. chanos) is known to reach a maximum 1 040 kg/ha/year in Laguna de Bay, where it is largely cultured in fishpens. Common carp reaches 46 kg/ha in Lake Buluan. The widely distributed tilapias (species not separated) reach a maximum of 247 kg/ha (Lake Bato), 117 kg/ha (Lake Paoay), and 89 kg/ha (Laguna de Bay). In the sample of 15 lakes and reservoirs, tilapias are regularly stocked in two (Laguna de Bay, Tal lake). C. carpio is regularly stocked in Laguna de Bay, and C. chanos in Laguna de Bay, Taal and Mainit. For C. chanos the major obstacle to increasing yield is the fry shortage and high mortality rates of fry during transport and storage; for tilapias it is the poor quality of produced fry/fingerlings for stocking. Culture in fish cages and in pens is a common feature on Philippines lakes and reservoirs, and the statistics sometimes do not distinguish the yield from such semi-intensive and intensive cultures and those from capture fisheries.

The food of the listed species is largely plankton and/or detritus, and in most of the medium and highly productive Philippines lakes it should not be a limiting factor for enhancing the yield of capture fisheries, although it would limit the yield in enclosures and cages. The feeding spectrum of adult fish is shown in Table 11.

Table 11

ADULT FEEDING HABITS

Food Species	bottom detritus	bottom mud	benthic fauna	auf-wuchs	macro-phytes	phyto-pl.	zoo-pl.
Chanos chanos	+	-	+	-	-	+	+
Cyprinus carpio	+	+	+	-	-	-	-
Oreochromis niloticus	-	-	-	+	+	+	+
Oreochromis mossambicus	+	-	+	+	+	+	+

Sri Lanka

Table 12

LIST OF SPECIES

Species	Family
Barbus (Puntius) sarana	Cyprinidae
Etroplus suratensis	Cichlidae
Labeo dussumieri	Cyprinidae

All three species are found in most reservoirs of Sri Lanka. They represent between 1 and 2 percent of the fish yield. This low percentage is due to the strong dominance in the yield of the exotic Oreochromis mossambicus. E. suratensis was transplanted into reservoirs from estuaries, while the other two species are indigenous and entered the reservoirs from the flooded rivers. No artificial breeding is needed to produce the stocking material. It is believed that stocking of B. (P.) sarana would not be cost-effective. The biology of E. suratensis requires further studies. The competitive eco-biological pressure of O. mossambicus on these species, occupying the same environment, needs to be evaluated. All three species feed on aquatic plants and detritus (Table 13).

Table 13

ADULT FEEDING HABITS

Food Species	bottom detritus	bottom mud	aufwuchs	macro-phytes	fruits,seeds
Barbus (Puntius) sarana	+	+	–	+	+(?)
Etroplus suratensis	+	–	–	+	–
Labeo dussumieri	+	–	+	–	–

Thailand

Table 14

LIST OF SPECIES

Species	Family
Cirrhinus jullieni	Cyprinidae
Clupeichthys aesarnensis	Clupeidae
Kryptopterus apogon	Siluridae
Labeo rohita	Cyprinidae
Oreochromis niloticus	Cichlidae
Puntius gonionotus	Cyprinidae

C. jullieni and L. rohita enter rivers for breeding. C. jullieni reaches a maximum of 24 kg/ha/year and 21 kg/ha/year in Ubolratana and Lam Pao reservoirs respectively; Clupeichthys gives 8.5 kg/ha/year (Sirithon reservoir). For the other species the following percentage of the total annual yield is given: L. rohita maximum 2.3 percent (Nam Oon reservoir), O. niloticus maximum 16 percent (Bhumipol reservoir), P. gonionotus maximum 22 percent (Ubolratana reservoir). L. rohita and O. niloticus are stocked in the four reservoirs listed in the present survey, while P. gonionotus, an indigenous species, present in all reservoirs, is also stocked into Ubolratana.

O. niloticus is suspected of competing with P. gonionotus and Puntioplites protozysion for food. Reproduction activities of some species are said to interfere with the reproduction of O. niloticus. P. protozysion and Osteochilus hasselti are reported to compete for food with P. gonionotus. The feeding spectrum of the adult fish is shown in Table 15.

Table 15

ADULT FEEDING HABITS

Food Species	bottom detritus	benthic mud	aufwuchs	phyto-plankton	zoo-plankton	terr. insects	fish
Cirrhinus jullieni	-	-	+	+	-	-	
Corica insannensis	-	-	-	+	+	-	-
Kryptopterus apogon	-	-	-	-	-	-	+
Labeo rohita	+	+	+	-	-	-	-
Oreochromis niloticus	+	-	-	+	+	+	-
Puntius gonionotus	-	-	-	+	+	-	-

Clupeichthys is a pelagic fish, feeding on plankton. Plankton is also the major component of three other species. L. rohita is a bottom feeder, and K. apogon is a piscivore.

DISCUSSION

The results of the analysed material show a wide variety of species considered of importance for enhancing fish yields in tropical and subtropical reservoirs and lakes of the IPFC region. Among the fish, fish predators are listed only by Australia (six species) and by Thailand (one species, Tables 2 and 3). The predominance of fish predators and/or insect feeders in Australia should be seen as a result of the major purpose of developing reservoir fish stocks, i.e., for recreational fishery. Other countries in the region concentrate on maximizing fish yield for production of fish as food, and this is reflected in their selection of fast growing fish feeding predominantly on plant material, plankton, bottom deposits.

The survey has not shown the importance of carps in the region, as individual rapporteurs concentrated largely on indigenous species. The exotic *O. niloticus* is omitted in the Sri Lanka list, although it represents some 98 pecent of the total yield from her reservoirs. Another exotic, silver carp (*H. molitrix*), is a commonly stocked species in Indian reservoirs and in some of them it represents a considerable proportion of the total yield. The exotic *O. niloticus* and *C. carpio* are listed by three countries each as being species used for enhancing fish yield, which shows that these species have a permanent position of importance in their inland fisheries.

There is a shortage of information on interactions and interrelationships between the best suitable species and their aquatic enviornment, including other fish. Biological and ecological data are still scarce for a number of species dealt with in this inventory, and this places a constraint on their use for fish yield enhancement in lakes and reservoirs of the region. Full attention should be given to the possible impact of transferred exotics into new environments, and of transfers of indigenous species from catchment to catchment, prior to implementation. More data should be obtained by long-term monitoring of catches, and a thorough analysis of the already existing data needs to be done to assist in a better understanding of processes determining high yields of tropical and subtropical waters of the IPFC region. Such information is essential for improving fishery management strategies and practices.

It is hoped that this inventory will be expanded by obtaining information from other tropical and subtropical countries of the region not included in the present survey, as well as by additional information from the countries which have already supplied some data for questionnaires. The Secretariat of the IPFC Working Party of Experts on Inland Fisheires would then consider producing the full information in the form of an FAO document.

A sample questionnaire is appended to this paper. Copies can be obtained from the Technical Secretary, IPFC Working Party of Experts on Inland Fisheries, FAO, Fisheries Department (FIR), 00100 Rome, Italy. Completed questionnaires should be mailed to the same address.

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Appendix I

QUESTIONNAIRE

COUNTRY: ....

1. IDENTIFICATION

Genus	Species	Family
....	....	....

2. BIOLOGY, ECOLOGY

Type of habitat: Pelagic ☐ Benthic ☐ Demersal ☐ Littoral ☐

2.1 Breeding:	Natural	yes ☐	no ☐
	Artificial	yes ☐	no ☐

2.2 Fry/fingerlings habitat requirements:

2.3 Adult feeding habits: (mark only those which are relevant)

bottom detritus

bottom mud

benthic fauna

aufwuchs (periphyton)

macrophytes

scavenger

fruits, seeds

phytoplankton

zooplankton

phyto and zooplankton

terrestrial insects on water surface

crabs

prawns

fish

2.4 Diurnal vertical migration: yes ☐ no ☐

2.5 Regular migration into inflowing streams, rivers: yes ☐ no ☐

2.6 Diseases, parasites:

2.7 Competition: List fish species with which it competes - water bodies in your country only.
For each species identify the area of competition.

3. Distribution (in lakes, reservoirs and other water bodies in which the speciea is found)

Name of waterbody	Type (lake, reservoir, dam, tank, swamp)	Maximum surface area (ha)	Maximum depth (m)	Maximum drawdown (m)	Drawdown: regular R; irregular IR	Conductivity of water (micromhos)	Temperature annual range °C	pH	Aquatic vegetation: littoral L; floating F; submersed S; rich R; poor P

4. Fisheries

Name of waterbody (same order as previous table)	Annual fishery yield (all species kg/ha)	Fisheries: intensive I; medium M; low L	Species forms % by weight in total yield	Species: exotic E; indigenous I; regularly stocked RS	Stocking material from: hatcheries H; wild stocks WS	Species in: cages C; pens P; not applicable NA	Supplement feeding: provided P; not provided NP	Species production (catch, yield) kg/ha/yr (or kg/m^3/yr for pens and cages

4.1 Describe the optimal environment in your country, in which the species will give the best yield.

4.2 Outline problems interfering with reaching the best yield in your country.

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4.3 Provide any additional information on the species and its habitat which you think needs clarification; why the species has a good fishery potential, or why it has been so successful in achieving high yields.

4.4 List basic literature references on the species for your country.

ANNEX F

LIST OF FISH SPECIES INTRODUCED TO THE COUNTRIES AND GEOGRAPHICAL ENTITIES OF THE INDO-PACIFIC
(prepared by R.L Welcomme)

This list is extracted from the following publication: Welcomme, R.L. (comp.), 1988, International introductions of inland aquatic species. FAO Fish.Tech.Pap., (294):318 p., and updated. [1/]

Country	Species	Intro-duced	Repro-ducing
Afghanistan	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1970s	Artificially
Afghanistan	Cyprinus carpio L.: CYPRINIDAE	1970s	Yes
Afghanistan	Salmo gairdneri (RICHARDSON): SALMONIDAE	Unknown	Yes
American Samoa	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
American Samoa	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
American Samoa	Poecilia mexicana STEIDACHNER: POECILIIDAE	Unknown	Yes
Australia	Acanthogobius flavimanus SCHLEGEL: GOBIIDAE	Unknown	Yes
Australia	Carassius auratus (L.) : CYPRINIDAE	Unknown	Yes
Australia	Cichlasoma nigrofasciatum (GUNTHER): CICHLIDAE	1920s	Yes
Australia	Cichlasoma octofasciatum (REGAN): CICHLIDAE	Unknown	Yes
Australia	Cyprinus carpio L.: CYPRINIDAE	1900s	Yes
Australia	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Australia	Gambusia dominicensis REGAN: POECILIIDAE	Unknown	Yes
Australia	Oncorhynchus tshawytscha (WALBAUM): SALMONIDAE	1877,1967	Yes
Australia	Oreochromis mossambices (PETERS): CICHLIDAE	Unknown	Yes
Australia	Oreochromis sp.: CICHLIDAE	Unknown	Artificially
Australia	Perca fluviatilis L.: PERCIDAE	1861,68	Yes
Australia	Phalloceros caedomaculatus (HENSEL): POECILIIDAE	Unknown	Yes
Australia	Poecilia latipiana (LE SUEUR): POECILIIDAE	1969	Yes
Australia	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Australia	Rutilus retilus (L.): CYPRINIDAE	1900s	Yes
Australia	Salmo gairdneri (RICHARDSON): SALMONIDAE	Unknown	Yes
Australia	Salmo salar L.: SALMONIDAE	1864-70,1	Artificially
Australia	Salmo tretta L.: SALMONIDAE	Unknown	Yes
Australia	Salvelinus fontinalis (MITCHILL): SALMONIDAE	Unknown	Artificially
Australia	Tilapia mariae BOULENGER: CICHLIDAE	1960s	Yes
Australia	Tinca tinca L. CYPRINIDAE	Unknown	Yes
Australia	Tridentiger trigonocephalus (GILL): GOBIIDAE	Unknown	Yes
Australia	Xiphophorus helleri HECKEL: POECILIIDAE	1965	Yes
Australia	Xiphophorus macelatus (GUNTHER): POECILIIDAE	Unknown	Yes
Australia	Xiphophorus sp.: POECILIIDAE	Unknown	Yes
Bangladesh	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1969	Artificially
Bangladesh	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1969	Artificially
Bangladesh	Oreochromis mossambicus (PETERS): CICHLIDAE	1954	Yes
Bangladesh	Oreochromis nilotices L.: CICHLIDAE	1974	Yes

[1/] In addition to the information provided in the following table, his publication also gives for each species a brief description, native range, from where introduced, reason for introduction, and comments.

Bhutan	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1985	
Bhutaa	Catla catla (HAMILTON): CYPRINIDAE	1985	
Bhutan	Cirrhinus mrigala (HAMILTON): CYPRINIDAE	1985	
Bhutan	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1984	No
Bhutan	Cyprinus carpio L.: CYPRINIDAE	1984	Yes
Bhutan	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1984	No
Bhutan	Labeo rohita (HAMILTON): CYPRINIDAE	1985	
Bhutan	Oreochromis niloticus L. CICHLIDAE	1985	
Bhutan	Salmo trutta L. SALMONIDAE	1930's	Yes
China	Clarias batrachus (L.): CLARIIDAE	1978	yes
China	Ictalurus punctatus (RAFINESQUE): ICTALURIDAE	1982	Unknown
China	Oreochromis mossambicus (PETERS): CICHLIDAE	1957	Yes
China	Oreochromis niloticus L.: CICHLIDAE	1978	Yes
China	Orthodon microlepidotus (AYRES): CYPRINIDAE	1982	Unknown
China	Salmo gairdneri (RICHARDSON): SALMONIDAE	1980s	Artificially
Colombia	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	Unknown	Yes
Cook Islands	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Cook Islands	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Cook Islands	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Federated States of Micronesi	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Fiji	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1968	Artificially
Fiji	Channa (Ophiocephalus) striata	Unknown	Yes
Fiji	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1968	Artificially
Fiji	Cyprinus carpio L.: CYPRINIDAE	1936	Doubtful
Fiji	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	1930s	Yes
Fiji	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1968	Artificially
Fiji	Micropterus dolomieui LACEPEDE: CENTRARCHIDAE	Unknown	Yes
Fiji	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	1962	Artificially
Fiji	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Fiji	Oreochromis ailoticus L.: CICHLIDAE	Unknown	Yes
Fiji	Poecilia mexicana STEIDACHNER: POECILIIDAE	Unknown	Yes
Fiji	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Artificially
Fiji	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Fiji	Pseudorasbora sp.: CYPRINIDAE	1984	Yes
Fiji	Puntius gonionotus (BLEEKER): CYPRINIDAE	1968	Yes
Fiji	Rhodeus ocellatus (KNER): CYPRINIDAE	1984	Yes
Fiji	Salmo trutta L.: SALMONIDAE	1920	Artificially
Fiji	Xiphophorus helleri HECKEL: POECILIIDAE	Unknown	Yes
Fiji	Xiphophorus helleri HECKEL: POECILIIDAE	Unknown	Yes
Guam	Astronotus ocellatus (AGASSIZ): CICHLIDAE	Unknown	Yes
Guam	Betta brederi MYERS: ANABANTIDAE	Unknown	Yes
Guam	Cichla ocellaris BLOCH and SCHNEIDER: CICHLIDAE	1966	Yes
Guam	Clarias batrachus (L.): CLARIIDAE	Unknown	Yes
Guam	Cyprinus carpio L.: CYPRINIDAE	Unknown	Yes
Guam	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Guam	Ictalurus punctatus (RAFINESQUE): ICTALURIDAE	1966	Artificially
Guam	Micropterus dolomieui LACEPEDE: CENTRARCHIDAE	1962	Artificially
Guam	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	1966	Artificially
Guam	Oreochromis mossambicus (PETERS): CICHLIDAE	1955	Yes
Guam	Poecilia latipinna (LE SUEUR): POECILIIDAE	Unknown	Yes
Guam	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Guam	Tilapia zillii (GERVAIS): CICHLIDAE	Unknown	Yes
Guam	Xiphophorus helleri HECKEL: POECILIIDAE	Unknown	Yes

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Hawaii	Aplochailus linaatus (CUVIER and VALENCIENNES): CYPRINODONTID	1960	Unknown
Hawaii	Astronotus ocaliatus (AGASSIZ): CICHLIDAE	1952	Yes
Hawaii	Barbus semifasciolatus GUNTHER: CYPRINIDAE	1940	Yes
Hawaii	Carassius auratus (L.) : CYPRINIDAE	1900	Yes
Hawaii	Cichia ocallaris BLOCH and SCHNEIDER: CICHLIDAE	1961	Yes
Hawaii	Cichlasoma maeki BRIND: CICHLIDAE	1940	Yes
Hawaii	Ctaaopharyngodon idella (VALENCIENNES): CYPRINIDAE	1968	No
Hawaii	Dorosoma pataaanse (GUNTHER): CLUPEIDAE	1958	Yes
Hawaii	Fundulus grandis BAIRD and GIRARD: POECILIIDAE	1905	No
Hawaii	Gambusia affiais (BAIRD and GIRARD): POECILIIDAE	1905	Yes
Hawaii	Ictalurus nebulosus (LESUEUR): ICTALURIDAE	1893	No
Hawaii	Ictalurus punctatus (RAFINESQUE): ICTALURIDAE	1953	Yes
Hawaii	Lapomis macrochirus RAFINESQUE: CENTRARCHIDAE	1946	Yes
Hawaii	Microptarus dolomieui LACEPEDE: CENTRARCHIDAE	1953	Yes
Hawaii	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	1897	Yes
Hawaii	Monoptarus albus (ZUIEW): SYNBRANCHIDAE	1900	Yes
Hawaii	Morone saxatilis (WALBAUM): PERCICHTHYIDAE	1920	No
Hawaii	Nothobranchius guenthari (PFEFFER): CYPRINODONTIDAE	1967	Unknown
Hawaii	Oncorhynchus tshawytscha (WALBAUM): SALMONIDAE	1876	No
Hawaii	Oraochromis macrochir (BOULENGER): CICHLIDAE	1958	Yes
Hawaii	Oryzias latipas (TEMMINCK and SCHLEGEL): ORYZIATIDAE	1922	No
Hawaii	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	1950	No
Hawaii	Poecilia spheaops (CUVIER and VALENCIENNES: POECILIIDAE	1950	Yes
Hawaii	Salmo gairdnari (RICHARDSON): SALMONIDAE	1920	Yes
Hawaii	Salmo trutta L.: SALMONIDAE	1935	No
Hawaii	Salveliaus fontinalis (MITCHILL): SALMONIDAE	1876	No
Hawaii	Trichogastar leeri (BLEEKER): OSPHRONEMIDAE	1940	No
Hawaii	Xiphophorus variatus (MEEK): POECILIIDAE	1960's	Yes
Hong Kong	Chanos chanos (FORSKAL): CHANIDAE	1956	No
Hong Kong	Clarias batrachus (L.): CLARIIDAE	1970	No
Hong Kong	Oreochromis mossambicus (PETERS): CICHLIDAE	1940,1948	Yes
Hong Kong	Oreochromis niloticus L.: CICHLIDAE	1972	Yes
Hong Kong	Trichogastar pactoralis (REGAN): OSPHRONEMIDAE	Unknown	Unknown
India	Carassius carassius L.: CYPRINIDAE	1870	Yes in Daty L. Ta
India	Ctaaopharyngodon idella (VALENCIENNES): CYPRINIDAE	1959,68	Artificially
India	Cyprinus carpio L.: CYPRINIDAE	1939,58°	Yes
India	Etroplus suratansis (BLOCH): CICHLIDAE	1958	Yes
India	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1959	Artificially
India	Oncorhynchus aerka WALBAUM: SALMONIDAE	1968	No
India	Oreochromis mossambicus (PETERS): CICHLIDAE	1952	Yes
India	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	1916	Yes
India	Puntius gonionotus (BLEEKER): CYPRINIDAE	1972	Yes
India	Salmo gairdnari (RICHARDSON): SALMONIDAE	1907, 12	Yes
India	Salmo trutta L.: SALMONIDAE	1900	Yes
India	Salveliaus fontiaalis (MITCHILL): SALMONIDAE	1963	Yes
India	Tinca tinca L. CYPRINIDAE	1870	Yes
India	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	Unknown	Unknown
Indonesia	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1964	Artificially
Indonesia	Chaana (Ophiocephalus) striata	Ancient	Yes
Indonesia	Cirrhiaus molitorella (CUVIER and VALENCIENNES): CYPRINIDAE	1964	Artificially
Indonesia	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1915,49,6	Artificially
Indonesia	Cyprinus carpio L.: CYPRINIDAE	1920s	Yes
Indonesia	Etroplus surateasis (BLOCH): CICHLIDAE	1979	Artificially
Indonesia	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1964,69	Artificially
Indonesia	Oreochromis mossambicus (PETERS): CICHLIDAE	1939	Yes
Indonesia	Oraochromis ailoticus L.: CICHLIDAE	1969	Yes
Indonesia	Pangasius sutchi FOWLER: PANGASIIDAE	1972	Artificially

Indonesia	Red Tilapia: CICHLIDAE	1981	Artificially
Indonesia	Salmo gairdneri (RICHARDSON): SALMONIDAE	1929	No
Indonesia	Salmo salar L.: SALMONIDAE	1929	No
Indonesia	Salmo trutta L.: SALMONIDAE	1929	No
Indonesia	Tinca tinca L. CYPRINIDAE	1927	Yes
Indonesia	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	1930	Yes
Indonesia, (Bali)	Helostoma temmincki KUHL and VAN HESSELT: ANABANTIDAE	Unknown	Unknown
Irian Jaya	Clarias batrachus (L.): CLARIIDAE	Unknown	
Irian Jaya	Cyprinus carpio L.: CYPRINIDAE	1937	
Irian Jaya	Helostoma temmincki KUHL and VAN HESSELT: ANABANTDAE	1937	
Irian Jaya	Orechromis niloticus L.: CICHLIDAE	1971	
Irian Jaya	Oreochromis mossambicus (PETERS): CICHLIDAE	1951	
Irian Jaya	Osphronemus gouramy (LACEPEDE): OSPHROMNEMIDAE	1937	
Irian Jaya	Osteochilus hasselti CUVIER and VALENCIENNES: CYPRINIDAE	1937	
Irian Jaya	Puntius gonionotus (BLEEKER):CYPRINIDAE	1963	
Irian Jaya	Puntius orphoides (CUVIER and VALECIENNES): CYPRINIDAE	1963	
Irian Jaya	Salmo gairdneri (RICHARDSON): SALMONIDAE	1983	
Irian Jaya	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	1937	
Islands E. of Wallace line	Aplocheilus panchax HAM. BUCH.: CYPRINODONTIDAE	Unknown	Yes
Japan	Anguilla anguilla L.: ANGUILLIDAE	1960s	Continuous import
Japan	Aplidonotus grunniens RAF.: SCIAENIDAE	Unknown	Unknown
Japan	Aristichthys nobilis RICHARDSON: CYPRINIDAE	Unknown	Artificially
Japan	Catla catla (HAM. BUCH.): CYPRINIDAE	Unknown	Artificially
Japan	Cirrhinus molitorella (CUVIER and VALENCIENNES): CYPRINIDAE	Unknown	Artificially
Japan	Lepomis cyanellus RAFINESQUE: CENTRARCHIDAE	Unknown	Unknown
Japan	Lepomis macrochirus RAFINESQUE: CENTRARCHIDAE	Unknown	Unknown
Japan	Odontesthes bonariensis (CUVIER and VALENCIENNES): ATHERINIDA	Unknown	Unknown
Japan	Oreochromis mossambicus (PETERS): CICHLIDAE	1954	Unknown
Japan	Procambarus clarkii (GIRARD): CRUSTACEA; ASTACIDAE	Unknown	Unknown
Japan	Salmo gairdneri (RICHARDSON): SALMONIDAE	1877	Yes
Japan	Salmo trutta L.: SALMONIDAE	1900	Yes
Japan	Salvelinus fontinalis (MITCHILL): SALMONIDAE	1901	Yes
Japan	Tilapia sparrmanii SMITH: CICHLIDAE	Unknown	Unknown
Japan	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	Unknown	Unknown
Kiribati	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Kiribati	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Korea	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1963	Artificially
Korea	Carassius auratus (L.) : CYPRINIDAE	1972	Yes
Korea	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1963	Artificially
Korea	Cyprinus carpio L.: CYPRINIDAE	1973	Yes
Korea	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1963	Artificially
Korea	Ictalurus punctatus (RAFINESQUE): ICTALURIDAE	1972	Unknown
Korea	Lepomis cyanellus RAFINESQUE: CENTRARCHIDAE	1969	Yes
Korea	Lepomis macrochirus RAFINESQUE: CENTRARCHIDAE	1969	Yes
Korea	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	1963	Yes
Korea	Oreochromis mossambicus (PETERS): CICHLIDAE	1953	Yes
Korea	Salmo gairdneri (RICHARDSON): SALMONIDAE	1965	Artificially
Laos	Oreochromis mossambicus (PETERS): CICHLIDAE	1955	Unknown
Malaysia	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1800's	Artificially
Malaysia	Catla catla (HAM. BUCH.): CYPRINIDAE	Unknown	Artificially
Malaysia	Cirrhinus molitorella (CUVIER and VALENCIENNES): CYPRINIDAE	Unknown	Artificially
Malaysia	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1800s	Artificially
Malaysia	Cyprinus carpio L.: CYPRINIDAE	1800s	Yes
Malaysia	Etroplus suratensis (BLOCH): CICHLIDAE	1975	Unknown
Malaysia	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1800s	Artificially
Malaysia	Oreochromis mossambicus (PETERS): CICHLIDAE	1943	Yes
Malaysia	Puntius gonionotus (BLEEKER): CYPRINIDAE	1958	Yes
Malaysia	Salmo gairdneri (RICHARDSON): SALMONIDAE	1935	Unknown
N. Zealand	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	1930	Yes
Nauru	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes

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Nepal	Aristichthys nobilis RICHARDSON: CYPRINIDAE	Unknown	
Nepal	Ctenopharyngodon idella	1984	No
Nepal	Cyprinus carpio L.: CYPRINIDAE	1970's	Yes
Nepal	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1984	No
Nepal	Oreochromis niloticus L. CICHLIDAE	1985	
Nepal	Salmo gairdneri (RICHARDSON): SALMONIDAE	Unknown	Unknown
New Caledonia	Channa (Ophiocephalus) striata	Unknown	Yes
New Caledonia	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	Unknown	Yes
New Caledonia	Oreochromis mossambicus (PETERS): CICHLIDAE	1955	Yes
New Caledonia	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	Unknown	Yes
New Caledonia	Tilapia zillii (GERVAIS): CICHLIDAE	Unknown	Yes
New Caledonia	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	Unknown	Yes
New Zealand	Carassius auratus (L.) : CYPRINIDAE	1864-68	Yes
New Zealand	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1967, 71	Artificially
New Zealand	Cyprinus carpio L.: CYPRINIDAE	1864-1911	Yes
New Zealand	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1969	Artificially
New Zealand	Ictalurus nebulosus (LESUEUR): ICTALURIDAE	1877	Yes
New Zealand	Oncorhynchus nerka WALBAUM: SALMONIDAE	Unknown	Yes
New Zealand	Oncorhynchus tshawytscha (WALBAUM): SALMONIDAE	1876/80,I	Yes
New Zealand	Oncorhynchus tshawytscha (WALBAUM): SALMONIDAE	1876/80,	Yes
New Zealand	Perca fluviatilis L.: PERCIDAE	Unknown	Artificially
New Zealand	Poecilia latipinna (LE SUEUR): POECILIIDAE	Unknown	Yes
New Zealand	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
New Zealand	Salmo gairdneri (RICHARDSON): SALMONIDAE	Unknown	Yes
New Zealand	Salmo salar L.: SALMONIDAE	1864-1910	Yes
New Zealand	Salmo trutta L.: SALMONIDAE	Unknown	Yes
New Zealand	Salvelinus fontinalis (MITCHILL): SALMONIDAE	Unknown	Artificially
New Zealand	Salvelinus namaycush (WALBAUM): SALMONIDAE	Unknown	Artificially
New Zealand	Scardinius erythrophthalmus (L.): CYPRINIDAE	Unknown	Artificially
New Zealand	Tinca tinca L. CYPRINIDAE	Unknown	Yes
Niue	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Northern Mariana Islands	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Northern Mariana Islands	Oreochromis mossambicus (PETERS): CICHLIDAE	1955	Yes
Pakistan	Catla catla	Unknown	Yes
Pakistan	Cirrhinus mrigala		Yes
Pakistan	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1964	Artificially
Pakistan	Labeo rohita		Yes
Pakistan	Oreochromis mossambicus (PETERS): CICHLIDAE	1951	Unknown
Pakistan	Salmo gairdneri (RICHARDSON): SALMONIDAE	Unknown	Yes
Pakistan	Salmo trutta L.: SALMONIDAE	1906	Yes
Pakistan	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	Unknown	Unknown
Palau	Misgurnus anguillicaudatus (CANTOR): COBITIDAE	Unknown	Yes
Palau	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Palau	Xiphophorus maculatus (GUNTHER): POECILIIDAE	Unknown	Yes
Papua New Guinea	Cyprinus carpio L.: CYPRINIDAE	1959	Yes
Papua New Guinea	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	1930	Yes
Papua New Guinea	Oreochromis mossambicus (PETERS): CICHLIDAE	1954	Yes
Papua New Guinea	Poecilia reticulata PETERS: POECILIIDAE	1967	Yes
Papua New Guinea	Puntius gonionotus (BLEEKER): CYPRINIDAE	1970	Unknown
Papua New Guinea	Salmo gairdneri (RICHARDSON): SALMONIDAE	1952	Yes
Papua New Guinea	Salmo trutta L.: SALMONIDAE	1949	Yes
Papua New Guinea	Salvelinus fontinalis (MITCHILL): SALMONIDAE	1974	Unknown
Papua New Guinea	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	1957	Yes
Papua New Guinea	Trichogaster trichopterus (PALLAS): OSPHRONEMIDAE	1970	Yes

Philipianes	Cyprinus carpio L.: CYPRINIDAE	1910, 15	Yes
Philipinnes	Lepomis cyanellus RAFINESQUE: CENTRARCHIDAE	1950	Yes
Philipianes	Poecilia latipinna (LE SUEUR): POECILIIDAE	Unknown	Yes
Philippines	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1968	Artificially
Philippines	Carassius carassius L.: CYPRINIDAE	1964	Yes
Philippines	Catla catla (HAM. BUCH.): CYPRINIDAE	1964	Yes
Philippines	Cirrhinus mrigala HAM. BUCH: CYPRINIDAE	1964	Artificially
Philippines	Clarias batrachus (L.): CLARIIDAE	1974	Yes
Philippines	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1964	Artificially
Philippines	Helostoma temmincki KUHL and VAN HESSELT: ANABANTIDAE	1948	Yes
Philippines	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1964,68	Artificially
Philippines	Labeo rohita HAMILTON: CYPRINIDAE	1964	Artificially
Philippiaes	Lepomis macrochirus RAFINESQUE: CENTRARCHIDAE	1950	Yes
Philippines	Micropterus salmoides (LACEPEDE): CENTRARCHIDAE	1907	Yes
Philippines	Misgurnus anguillicaudatus (CANTOR): COBITIDAE	1942	Yes
Philippines	Oreochromis aureus (STEINDACHNER): CICHLIDAE	1977	Yes
Philippines	Oreochromis mossambicus (PETERS): CICHLIDAE	1950	Unknown
Philippines	Oreochromis ailoticus L.: CICHLIDAE	1970,73	Yes
Philippines	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	1927	Yes
Philippines	Puntius gonionotus (BLEEKER): CYPRINIDAE	1956	Yes
Philippines	Trichogaster leeri (BLEEKER): OSPHRONEMIDAE	1938	Yes
Philippines	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	1938	Yes
Philippines	Trichogaster trichopterus (PALLAS): OSPHRONEMIDAE	1938	Yes
Singapore	Oreochromis aureus (STEINDACHNER): CICHLIDAE	Unknown	Unknown
Singapore	Oreochromis mossambicus (PETERS): CICHLIDAE	1943	Unknown
Singapore	Poecilia latipinna (LE SUEUR): POECILIIDAE	Unknown	Unknown
Solomon Islands	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Sri Lanka	Aristichthys aobilis RICHARDSON: CYPRINIDAE	1948	Artificially
Sri Lanka	Carassius carassius L.: CYPRINIDAE	1915	Yes
Sri Lanka	Catla catla (HAM. BUCH.): CYPRINIDAE	Unknown	Artificially
Sri Lanka	Cirrhiaus mrigala HAM. BUCH: CYPRINIDAE	1981	Artificially
Sri Lanka	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1948	Artificially
Sri Lanka	Cyprinus carpio L.: CYPRINIDAE	1915	Yes
Sri Lanka	Helostoma temmiacki KUHL aad VAN HESSELT: ANABANTIDAE	1951	Yes
Sri Lanka	Helostoma temmincki KUHL and VAN HESSELT: ANABANTIDAE	1951	Artificially
Sri Lanka	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1948	Artificially
Sri Lanka	Labeo rohita HAMILTON: CYPRINIDAE	1981	Artificially
Sri Lanka	Oreochromis hornorum (TREWAVAS): CICHLIDAE	1969	Artificially
Sri Lanka	Oreochromis mossambicus (PETERS): CICHLIDAE	1952	Yes
Sri Lanka	Oreochromis niloticus L.: CICHLIDAE	Unknown	Yes
Sri Lanka	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	1939	Yes
Sri Lanka	Poecilia reticulata PETERS: POECILIIDAE	1930s	Yes
Sri Lanka	Puntius gonionotus (BLEEKER): CYPRINIDAE	1968	Unknown
Sri Lanka	Salmo gairdneri (RICHARDSON): SALMONIDAE	1889	Yes
Sri Lanka	Salmo trutta L.: SALMONIDAE	1882	Artificially
Sri Lanka	Tilapia rendalli BOULENGER: CICHLIDAE	1969	Yes
Sri Lanka	Tilapia rendalli BOULENGER: CICHLIDAE	1955	Yes
Sri Lanka	Tilapia zillii (GERVAIS): CICHLIDAE	1969	Artificially
Sri Lanka	Trichogaster pectoralis (REGAN): OSPHRONEMIDAE	1951	Yes
Sri Lanka	Trichogaster trichopterus (PALLAS): OSPHRONEMIDAE	1948,49	Yes
Sri Lanka	Xiphophorus helleri HECKEL: POECILIIDAE	1960s	Yes
Sulawesi	Clarias batrachus (L.): CLARIIDAE	1939	Yes
Sulawesi	Helostoma temmincki KUHL and VAN HESSELT: ANABANTIDAE	Unknown	Unknown
Sulawesi	Puntius gonionotus (BLEEKER): CYPRINIDAE	1930	Yes

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Tahiti	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Tahiti	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Tahiti	Poecilia mexicana STEIDACHNER: POECILIIDAE	Unknown	Yes
Tahiti	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes
Taiwan	Salmo gairdneri (RICHARDSON): SALMONIDAE	1957	Yes
Thailand	Anguilla japonica TEMMINCK AND SCHLEGEL: ANGUILLIDAE	1973+	Continuous import
Thailand	Aristichthys nobilis RICHARDSON: CYPRINIDAE	1913	Artificially
Thailand	Cirrhinus molitorella (CUVIER and VALENCIENNES): CYPRINIDAE	Unknown	Artificially
Thailand	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	1913	Artificially
Thailand	Cyprinus carpio L.: CYPRINIDAE	1913	Yes
Thailand	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	1913	Artificially
Thailand	Labeo rohita HAMILTON: CYPRINIDAE	1968	Artificially
Thailand	Mylopharyngodon aetiops (RICHARDSON): CYPRINIDAE	1913	No
Thailand	Oreochromis mossambicus (PETERS): CICHLIDAE	1949	Yes
Thailand	Oreochromis niloticus L.: CICHLIDAE	1965	Yes
Thailand	Osphronemus gouramy (LACEPEDE): OSPHRONEMIDAE	Unknown	Unknown
Tonga	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Vanuatu	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Vietnam	Aristichthys nobilis RICHARDSON: CYPRINIDAE	Unknown	Artificially
Vietnam	Carassius auratus (L.) : CYPRINIDAE	Unknown	Unknown
Vietnam	Ctenopharyngodon idella (VALENCIENNES): CYPRINIDAE	Unknown	Artificially
Vietnam	Hypophthalmichthys molitrix (VALENCIENNES): CYPRINIDAE	Unknown	Artificially
Vietnam	Mylopharyngodon piceus (RICHARDSON): CYPRINIDAE	Unknown	Artificially
Vietnam	Oreochromis mossambicus (PETERS): CICHLIDAE	1955	Unknown
Vietnam	Oreochromis niloticus L.: CICHLIDAE	Unknown	Yes
Wallis and Fortuna	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Western Samoa	Carassius auratus (L.) : CYPRINIDAE	Unknown	Yes
Western Samoa	Gambusia affinis (BAIRD and GIRARD): POECILIIDAE	Unknown	Yes
Western Samoa	Oreochromis mossambicus (PETERS): CICHLIDAE	Unknown	Yes
Western Samoa	Poecilia mexicana STEIDACHNER: POECILIIDAE	Unknown	Yes
Western Samoa	Poecilia reticulata PETERS: POECILIIDAE	Unknown	Yes

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ANNEX G

MINING IMPACTS ON FISH STOCKS AND FISHERIES IN INLAND WATERS

(prepared by the Secretariat)

Mining activities usually result in changes in water quality, water quantity and sometimes also in change of the pattern of water discharge. Such changes may have impact on fish stocks of rivers, lakes, reservoirs, swamps, estuaries and coastal waters. The extent of the impact varies depending on how the water quality is improved before being discharged from the mine or ore processing area. Complete removal of sediments, heavy metals and chemicals used for ore processing and other activities may not always be possible.

Maintaining good water quality and sufficient quantity downstream of mines is in the interest of fishery managers and fishermen communities. Disappearance or damage to fish stocks may lead to major socio-economic disruptions and result in migration of the fisherfolk community or communities out of the affected area. Mines may financially compensate the fisherfolk for damages, but the compensation, if not handled properly, may not improve the lot of the affected communities. Governments are usually well aware of the mining-associated problems, and through their various departments and by using available legislation, exert some pressure on mines which may result in preventive and/or rehabilitation measures which reduce the damage to the environment.

In the IPFC member countries mining belongs to one of the socio-economically most important activities. The number of open and underground mines and oil drilling activities is increasing. The discharge of waste has affected different types of waters, their fish stocks, and in some situations also fisheries. The damage has been more serious where short rivers are used for the discharge of waste. In large rivers, the dilution of waste results in lesser damage to fish stocks. However, the extent of the damage ceused by mining ectivities is still poorly understood, and there is a need for a review of the problem area. Such a review should look into the problem on a country by country basis and cover the major types of mining and associated activities which have direct impact on fish stocks. The review should attempt to grade the mining types and activities according to their level of impact. The review should be followed up by preparetion of guidelines on preventive and rehabilitation measures. Such guidelines, addressed to governments and mining companies, should indicate the extent of damages to fish stocks, fisheries and fisherfolk, both in biological and in socio-economic terms, which might be expected, and to propose preventive and rehabilitation measures.

Some six years ago, a 'Fish and Wildlife Relationships to Mining Committee' was established in the USA. It represents a specialized unit within the Water Quality Section of the American Fisheries Society. In 1983 it published a paper summarizing the problem area and putting forward ideas for further action (1983, Starnes in 'Fisheries', Vol.8, No.6:2-4). Some of these are relevant to the problems in member countries of IPFC. The Committee also regularly produces a membership directory, an annual surface mining bibliography, as well as a newsletter. Some of the member countries of the IPFC might consider the establishment of a working group on mining problems, which could be attached to their Fisheries or Environment Department.

Relevant legislation on mining as it effects water resources, fish and fisheries, should also be collated and compared and the most suitable one discussed for its applicetion in those countries where improvement is needed.

ANNEX H

LIST OF COUNTRY STATUS REPORTS ON INLAND FISHERIES[1]
(edited by T. Petr)

Recent development of China's inland fisheries (Tong He-Yi)

Recent developments in inland fisheries of Nepal (B.P. Sharma)

The status of freshwater capture fisheries in Sri Lanka (A.M. Jayasekara)

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[1] Full versions of these papers are produced as supplement volume to this report.

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